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OPERATION MANUAL

MS420[ ] GP-IB INTERFACE

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MP MASTER
MA35868

ANRITSU ELECTRIC CO., LTD.

TOKYO, JAPAN

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CONTENTS

SECTION 1 GENERAL 1-1

SECTION 2 GP-IB FUNCTIONS

2.1 GP-IB Functions as Talker/Listener 2-1

2.2 GP-IB Controller Functions 2-1

SECTION 3 GP-IB ADDRESSES

3.1 GP-IB ADDRESSES 3-1

3.2 Modifying GP-IB Address with Address Switch 3-3

3.3 Modifying GP-IB Address with Front Panel Keys 3-4

3.3.1 GP-IB address verification 3-4

3.3.2 GP-IB address modification 3-4

3.3.3 Procedure for setting the MS420[ ] to controller 3-5

SECTION 4 DEVICE MESSAGES

4.1 Explanation of MS420[ ] Device Messages 4-1

4.2 General Formats of Control Message 4-2

4.2.1 Control message format 1 4-2

4.2.2 Control message format 2 4-2

4.2.3 Control message format 3 4-3

4.2.4 Control message format 4 4-3

4.3 General Formats of Data Request Messages 4-4

4.3.1 Data request message format 1 4-4

4.3.2 Data request message format 2 4-4

SECTION 5 DETAILS OF DEVICE MESSAGES

5.1 DISPLAY FUNCTION 5-1

5.1.1 TRACE 5-1

5.1.2 LIN/IF RANGE/TRIGGER LEVEL 5-2

5.1.3 EXP 5-2

5.1.4 MARKER 5-3

5.1.5 SUB TRACE 5-4

5.1.6 SCALE A/B 5-4

5.1.7 OFFSET A/B 5-5

5.2 MEASURE FUNCTION 5-5

5.2.1 LOG START/STOP FREQUENCY 5-5

5.2.2 LIN START/STOP FREQUENCY 5-6

CONTENTS (Cont'd)

5.2.3 LIN CENTER/SPAN FREQUENCY 5-6
5.2.4 FREQUENCY SETTING 5-6
5.2.5 OUTPUT (START)/STOP/STEP LEVEL 5-7
5.2.6 LEVEL SWEEP 5-7
5.2.7 INPUT RANGE 5-7
5.2.8 DELAY RANGE 5-8
5.2.9 RES/VIDEO BW 5-9
5.2.10 SWEEP TIME 5-9
5.2.11 IMPEDANCE R/T 5-10
5.2.12 OUTPUT A/B 5-10
5.2.13 SIGNAL TRACK 5-10
5.2.14 COUPLED TO FREQ 5-11
5.2.15 COUPLED TO SPAN 5-11
5.2.16 CAL (X-S) 5-11
5.2.17 TRACK ADJ 5-12
5.2.18 UNCAL 5-12
5.2.19 OVER LOAD 5-12
5.3 CONTROL FUNCTION 5-13
5.3.1 SWEEP AUTO/MARKER 5-13
5.3.2 SWEEP STOP/RESET 5-13
5.3.3 SWEEP REPEAT/SINGLE START 5-13
5.3.4 PTA 5-14
5.3.5 CAL INT 5-14
5.3.6 CAL X → S 5-14
5.3.7 SAVE 5-14
5.3.8 RECALL 5-15
5.3.9 INITIAL SET 5-15
5.3.10 BREAK POINT 5-16
5.4 ADV FUNCTION 5-16
5.4.1 INTEGRATING 5-16
5.4.2 MAX. HOLD 5-16
5.4.3 FREQUENCY COUNT 5-17
5.4.4 SWEEP MARKER 5-17
5.4.5 BUZZER 5-17
5.4.6 AUTO CAL. TIMER 5-18
5.4.7 TITLE 5-18
5.4.8 SRQ 5-18

CONTENTS (Cont'd)

5.4.9 DELIMIT 5-19
5.4.10 SEND 5-19
5.5 Measurement Memory 5-19
5.5.1 Frequency memory 5-19
5.5.2 Output level memory 5-21
5.5.3 Measurement memory for channel A 5-22
5.5.4 Measurement memory for channel B 5-23
5.5.5 S memory for channel A 5-24
5.5.6 S memory for channel B 5-24
5.5.7 Reading measurement results 5-24
5.5.8 MEMORY SYSTEM 5-26
5.6 Device Messages on CRT Coordinates 5-32
5.6.1 Display delete message 5-32
5.6.2 Character display message 5-32
5.6.3 Graphic display message 5-33
5.6.4 CRT coordinate 5-33
5.6.5 Program example for CRT control 5-35

SECTION 6 INTERRUPT

6.1 Serial Polling 6-1
6.2 Status Byte 6-1
6.3 Example 6-2
6.3.1 SWEEP ended 6-2
6.3.2 SEND 6-2
6.3.3 PTA 6-2

SECTION 7 ADV FUNCTION OF GP-IB

7.1 GP-IB Commands 7-1
7.1.1 ADR command 7-1
7.1.2 SRQ command 7-1
7.1.3 DLI command 7-2
7.1.4 SND command 7-2
7.2 DATA OUT (Printing out Measurement Results) 7-3
7.3 WRITE 7-4
7.4 READ 7-4

CONTENTS (Cont'd)

SECTION 8 PROGRAM EXAMPLES

8.1 General 8-1
8.2 Programming Techniques 8-2
8.3 Program for Measuring a 21.4 MHz Intermediate Frequency Filter 8-3
8.4 Program for Rapid Measurement by Decreasing Measurement Points 8-7
8.5 Program for Measuring Input Signal Frequency and Level 8-10
8.6 Frequency offset tracking 8-12

APPENDIX 1 CORRESPONDENCE BETWEEN DEVICE MESSAGES AND FUNCTION KEYS A-1-1

APPENDIX 2 LIST OF MS420[ ] DEVICE MESSAGES A-2-1

APPENDIX 3 FRONT PANEL STATUS AT POWER-ON A-3-1

SECTION 1 GENERAL

The GP-IB (General Purpose Interface Bus) interface is provided as standard equipment with the MS420[ ] Network/Spectrum Analyzer.

The GP-IB is a standard interface bus specified in IEEE-488 (Institute of Electrical and Electronics Engineers) and IEC-625 (International Electrotechnical Commission).

GP-IB enables all MS420[ ] functions, except the POWER switch and CRT INTENSITY knob, to be remotely controlled. In addition, the CRT can be used as a character/graphics terminal in personal computer systems. Thus, by connecting the MS420[ ] to a personal computer or another measuring device, a flexible system can easily be configured.

Since the MS420[ ] is capable of functioning as a GP-IB controller, the MS420[ ] can print out measurement results and handle frequency offset tracking with a synthesizer.

Moreover, by adding the Personal Test Automation (PTA) option, flexible systems can be configured without personal computer.

For details on GP-IB, ask your dealer or representative for a copy of the "INTRODUCTION TO GP-IB SYSTEMS".

Note: 1. *Models MS420B and MS420K are provided for 75 Ω and 50 Ω respectively. MS420[ ] represents both models.*
2. *The reader will be able to understand the contents of this manual more easily by starting with SECTION 8 EXAMPLE PROGRAMS.*
3. *The MS420[ ] Network/Spectrum Analyzer Operation Manual and Packet II Hy Personal Computer Operation Manual should be used for reference.*

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SECTION 2 GP-IB FUNCTIONS

The GP-IB functions of the MS420[ ] Network/Spectrum Analyzer are shown below.

2.1 GP-IB Functions as Talker/Listener

SH1	····· Source handshake function provided
AH1	····· Accept handshake function provided
T6	····· Talker function provided, talk only function not provided
L4	····· Listener function provided, listen only function not provided
SR1	····· Serial polling function provided
RL1	····· Remote/local function provided
PP0	····· Parallel polling function not provided
DC0	····· Device clear function not provided
DT0	····· Device trigger function not provided

2.2 GP-IB Controller Functions

C1	Response function for SRQ not provided, controller transmission function not provided.
C3	
C28	

For switching between controller and talker/listener functions, see SECTION 3, CP-IB ADDRESSES.

SECTION 3 GP-IB ADDRESSES

3.1 GP-IB ADDRESSES

The GP-IB has addresses for each device. Listener and talker are specified by MLA (My Listen Address) or MTA (My Talk Address) from the controller.

The device is usually provided with dip switches or a rotary switch either inside the device or on the rear panel, for modifying addresses as required.

GP-IB addresses are represented by bits 1 to 5 of the DIO line. The relationship between GP-IB address commands and ASCII codes is given in Table 3-1.

In the MS420[ ] Network/Spectrum Analyzer, the address switch is mounted on the GP-IB PC board. The address set by this switch is enabled when power is turned on.

In addition, addresses can be verified and modified from the keys on the front panel by using the ADV FUNCTION.

Table 3-1 Relationship between address commands and ASCII codes

	Listen address command			Talk address command		
	b8	b7	b6	b8	b7	b6
b5 b4 b3 b2 b1	0	0	1	0	1	0
0 0 0 0 0	(SPACE)			@		
0 0 0 0 1	!			A		
0 0 0 1 0	"			B		
0 0 0 1 1	#			C		
0 0 1 0 0	$			D		
0 0 1 0 1	%			E		
0 0 1 1 0	&			F		
0 0 1 1 1	'			G		
0 1 0 0 0	(			H		
0 1 0 0 1	)			I		
0 1 0 1 0	*			J		
0 1 0 1 1	+			K		
0 1 1 0 0	,			L		
0 1 1 0 1	−			M		
0 1 1 1 0	.			N		
0 1 1 1 1	/			O		
1 0 0 0 0	0			P		
1 0 0 0 1	1			Q		
1 0 0 1 0	2			R		
1 0 0 1 1	3			S		
1 0 1 0 0	4			T		
1 0 1 0 1	5			U		
1 0 1 1 0	6			V		
1 0 1 1 1	7			W		
1 1 0 0 0	8			X		
1 1 0 0 1	9			Y		
1 1 0 1 0	:			Z		
1 1 0 1 1	;			[		
1 1 1 0 0	<			\		
1 1 1 0 1	=			]		
1 1 1 1 0	>			↑		
1 1 1 1 1	? (UNL)			− (UNT)		

UNL: Unlisten command
UNT: Untalk command

3.2 Modifying GP-IB Address with Address Switch

Figure 3-1 shows the locations of the PC board and the address switches for GP-IB.

The GP-IB PC board can be extracted after removing the top cover of the MS420[ ].

Figure 3-2 shows details of the address dip switches. Address bits A1 to A5 must be set appropriately, and switch 8 must be set to DEVICE (ON) when using MS420[ ] as a talker/listener.

When using MS420[ ] as a controller, set switch 8 to CONTROLLER (OFF), leaving switches 6 and 7 off. When power is turned on, MS420[ ] is set as a controller.

At the factory, MS420[ ] is set as shown in Figure 3-2 (address is 1).

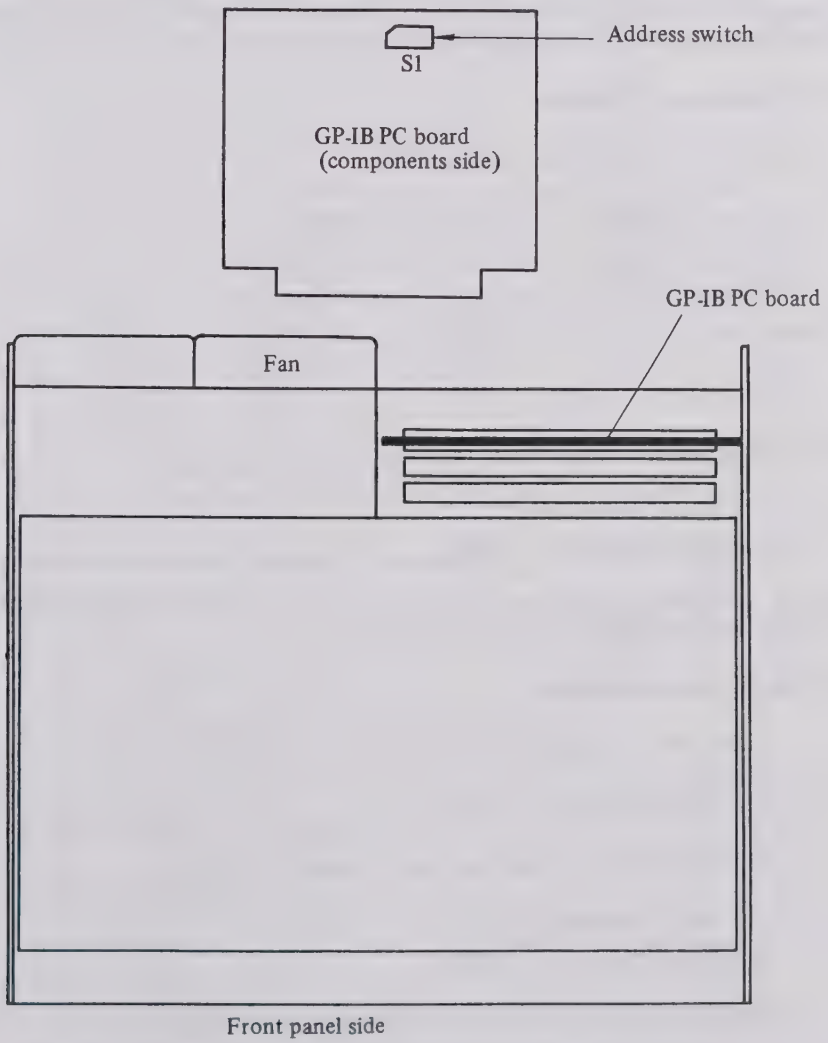


Fig. 3-1 Location of GP-IB PC board and address switches (top view)

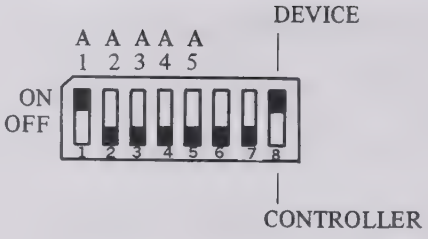


Fig. 3-2 Address switches

3.3 Modifying GP-IB Address with Front Panel Keys

GP-IB addresses can be verified and modified with the front panel keys. The GP-IB COMMAND of the ADV FUNCTION is used for verifying and modifying the addresses. For details on the ADV FUNCTION, refer to ADV FUNCTION in paragraph 2.8-(35) of the MS420[ ] Network/Spectrum Analyzer Operation Manual.

3.3.1 GP-IB address verification

(1) Call ADV line of the GP-IB COMMAND

Press keys [BEGIN] [/] [1] [0] [EOL] in this order.

```
1 0  GP-IB COMMAND
```

(2) Press keys [A] [D] [R] [?] [EOL] in this order.

```
1 0  GP-IB COMMAND    ADR?
```

(3) GP-IB address is displayed on the line above the ADV line.

```
      GP-IB ADDRESS(1)
1 0  GP-IB COMMAND    ADR?
```

Note: To verify the GP-IB address again, repeat step (2). The SYNTAX ERROR message will be displayed if only [EOL] key is pressed in step (3).

3.3.2 GP-IB address modification

(1) To modify addresses, press keys [A] [D] [R] [9] [EOL] in this order.

```
1 0  GP-IB COMMAND    ADR9
```

(2) The modified address is displayed on the line above the ADV Line.

```
      GP-IB ADDRESS(9)
1 0  GP-IB COMMAND    ADR9
```

The correspondence of keys and GP-IB addresses is given in Table 3-2.

Note: To modify the GP-IB address again, repeat step (1). The SYNTAX ERROR message will be displayed if only [EOL] key is pressed in step (2).

Table 3-2 Correspondence of address set keys and addresses

Address	Address set key	Address	Address set key
0	[0]	16	*1
1	[1]	17	[A]
2	[2]	18	[B]
3	[3]	19	*2
4	[4]	20	[D]
5	[5]	21	[E]
6	[6]	22	[F]
7	[7]	23	[G]
8	[8]	24	[H]
9	[9]	25	[I]
10	[:]	26	[J]
11	[;]	27	[K]
12	[<]	28	[L]
13	[=]	29	[M]
14	[>]	30	[N]
15	*1		

*1: No address set keys are provided.
*2: Key for setting MS420[ ] as a controller is used.

3.3.3 Procedure for setting the MS420[ ] to controller

(1) To use the MS420[ ] as a controller, press keys [A] [D] [R] [C] [EOL] in this order

```
1 0  GP-IB COMMAND     ADRC
```

(2) The following appears on the line above the ADV Line.

```
        GP-IB CONTROLLER
1 0  GP-IB COMMAND     ADRC
```

Note: See the note in paragraph 3.3.2.

SECTION 4 DEVICE MESSAGES

4.1 Explanation of MS420[ ] Device Messages

Device messages are commands for controlling the MS420[ ] and data transmission by the MS420[ ]. There are two types of device messages: control messages for controlling MS420[ ] and data request messages for reading data from the MS420[ ].

Figure 4-1 is a diagram of MS420[ ] device message syntax.

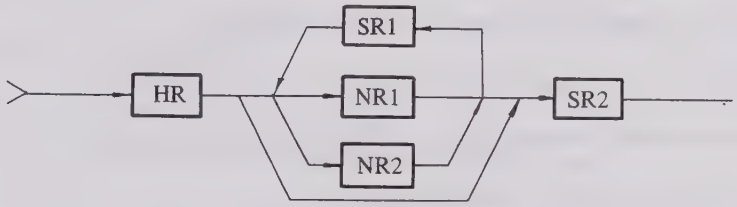


Fig. 4-1 Device message syntax

(1) Header (HR) field

The HR field indicates the type and contents of the data, and appears at the head of the device message. In the MS420[ ], the HR field is represented by two or three uppercase letters corresponding to the function indicated on the front panel. If undefined HR is used in a device message, this device message is ignored.

(2) Numeric (NR) field

The NR field is a data field indicating numeric values. There are two formats:

- NR1 format: Integer
- NR2 format: Real number

(3) Separator (SR) field

The SR field is a separator symbol field indicating the end of a data value or a message. When several messages are transmitted sequentially, the SR field is inserted between the messages to indicate the end of each message transmission and the start of the subsequent message.
There are two types of SR fields:

- SR1 type: Comma (,)
- SR2 type: Either line feed (LF) or carriage return·line feed (CR·LF) can be accepted. CR and LF in ASCII code are 0D and 0A in hexadecimal, respectively.

Note: 1. Device messages are explained in further detail in Section 5.
2. The correspondence of device messages and function keys is given as Appendix 1, and a list of device messages is given as Appendix 2.

4.2 General Formats of Control Message

Control messages are used to control the MS420[ ] operation. There are four formats, each will be explained by using instructions for the Packet II Personal Computer. (In Packet II WRITE statement, SR2 is automatically output at the end of each message.)

4.2.1 Control message format 1

This message format consists of a HR and SR2 as shown in the figure.

Program example

If the following instruction is executed, SR2 is automatically output after HR:

```
WRITE @101: "IN"
            |||
            ||└── HR of INITIAL SET
            |└─── GP-IB address of MS420[ ]
            └──── Select code of Packet II interface
```

4.2.2 Control message format 2

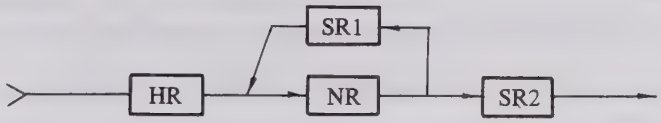
This message format consists of a HR, a NR, and SR2 as shown in the figure.

Program example

```
WRITE @101: "TR0"
            ||└── NR for MAG setting
            |└─── HR for TRACE

WRITE @101 USING "C, A": "EX", E
                         ||└── NR (variable) for switching EXP
                         |└─── HR for EXP
```

4.2.3 Control message format 3



This message format is used to repeat the combination of a NR and a SR1 several times between a HR and SR2 as shown in the above figure.

Program example

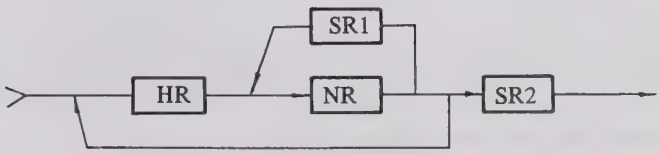
WRITE @101: "FC100, 1000"

- NR for SPAN frequency
- SR1
- NR for CENTER frequency
- HR for CENTER/SPAN

WRITE @101: "BW6, 7"

- NR for VBW
- SR1
- NR for RBW
- HR for RBW/VBW

4.2.4 Control message format 4



This message format is used to transmit two or more control messages at one time. The MS420[ ] can receive two or more control messages at one time, except for some specific message combinations.

Program example

WRITE @101: "TR0 BW6, 7 IR3"

Note that the following message combinations are not available:

(1) TRACE and SCALE A/B or OFFSET A/B

(2) Functions which can be set to ON only by TRACE and LEVEL or SPECT

(3) REPEAT START or SINGLE START and other control messages

(4) CAL (X → S) and other control messages

(5) INITIAL SET and other control messages

4.3 General Formats of Data Request Messages

A data request message is used to read data of functions, measurement results, and measurement memory from the MS420[ ]. A data request message header consists of a control message header added character R.

To read data from the MS420[ ], a data request message must be sent just before the operation.

> When the MS420[ ] is a talker, (CR)(LF) is added to the end of the data and transmitted.
> The data is the same format as a control message with HR and SR2 removed.

There are two formats:

4.3.1 Data request message format 1

This message format consists of a HR and SR2.

Program example

```
100 WRITE @101: "TRR"
110 READ @101: A
```

4.3.2 Data request message format 2

This message format consists of HR, NR, SR1, NR, and SR2.

Program example

```
100 WRITE @101: "XAR0, 251"
110 FOR I=0 TO 250
120 READ @101: A(I)
130 NEXT I
```

SECTION 5 DETAILS OF DEVICE MESSAGES

In this Section, MS420[ ] device messages are explained in detail. For function settings at power-up, see APPENDIX 3 FRONT PANEL STATUS AT POWER-ON.

5.1 DISPLAY FUNCTION

5.1.1 TRACE

(1) Control message

TRm Sets corrrsponding TRACE function

m	TRACE
0	MAG
1	PHA
2	DLY
3	LEVEL (R)
4	LEVEL (T)
5	MAG
6	MAG/PHA
7	MAG/DLY
8	SPECT (R)
9	SPECT (T)

(2) Data request message

TRR

5.1.2 LIN/RANGE/TRIGGER LEVEL

(1) Control message

LIn, m, l Sets on/off the LIN, IF RANGE value, and TRIGGER LEVEL. The **RANGE** value displayed on the CRT is the sum of the IF RANGE and INPUT RANGE values.

n	LIN
0	OFF
1	ON

m	IF RANGE
0	–90 dBm
1	–80
2	–70
3	–60
4	–50
5	–40
6	–30
7	–20
8	–10
9	0

l: 0 ~ 3800 This value indicates the trigger marker position. 0 is the lowest and 3800 is the highest position on the CRT scale.

*Note: When TRACE is not **LEVEL** or **SPECT**, this control message is always OFF.*

(2) Data request message

LIR

5.1.3 EXP

(1) Control message

EXn Turns on/off the EXPAND LIN/DLY function.

n	EXP
0	OFF
1	ON

Note: When TRACE is not **DLY**, ***M/D*, *LEVEL*, or *SPECT*, and *LIN* is ON, this control message is always OFF.**

(2) Data request message

EXR

5.1.4 MARKER

(1) Control message

MKm, ℓ Switches MARKER FUNCTION and sets the MAIN MARKER point.

m	MARKER FUNCTION
0	MAIN MARKER
1	ΔMARKER
2	ZERO

The specification of m can be omitted. When m is omitted, only MARKER moving is performed.

ℓ = 0 ~ 250 Indicates the MARKER point.

Note: When m=1 or 2, that is, when the MARKER FUNCTION is ΔMARKER or ZERO, ℓ is ignored.

Program example

(a) When the MARKER point is set at 100

```
100 WRITE @101: "MK, 100"
```

(b) When ΔMARKER is set at points 50 and 100

```
100 WRITE @101: "MK, 50"
110 WRITE @101: "MK1"
120 WRITE @101: "MK, 100"
```

(c) When ZERO MARKER is set at point 200 with point 125 as the base point.

```
100 WRITE @101: "MK, 125"
110 WRITE @101: "MK2"
120 WRITE @101: "MK, 200"
```

(d) When ΔMARKER or ZERO is switched to MAIN MARKER and MARKER is set at point 100.

```
100 WRITE @101: "MK0, 100"
```

(2) Data request message

MKR

5.1.5 SUB TRACE

(1) Control message

AXn, m Sets SUB TRACE.

n	SUB TRACE
0	OFF
1	ON

m	SUB TRACE
0	A → B
1	A = B
2	A – B

Note: This message is not executed when TRACE is M/P, M/D.

(2) Data request message

AXR

5.1.6 SCALE A/B

(1) Control message

SCm1, m2 This message sets SCALE A/B. Values ml and m2 indicate SCALE A and SCALE B, respectively.
SCm1 Sets SCALE A.
SC, m2 Sets SCALE B.

m1, m2	MAG, LEVEL (R)/(T), SPECT (R)/(T)	PHA	DLY
0	0.1 dB/	1 deg/	1 (see Note)
1	0.2	2	2
2	0.5	5	5
3	1	10	10
4	2	20	20
5	3	50	50
6	4	100	100
7	5	200	200

*Note: SCALE of DLY is obtained by multiplying the value shown in the above table by one hundredth (EXP off) or one thousandth (EXP on) of **DELAY RANGE** (1 μs ~ 400 ms).*

(2) Data request message

SCR

5.1.7 OFFSET A/B

(1) Control message

OFℓ1, ℓ2 Sets OFFSET A/B. Values ℓ1 and ℓ2 indicate OFFSET A and OFFSET B, respectively.
OFℓ1 Sets OFFSET A.
OF, ℓ2 Sets OFFSET B.

ℓ1, ℓ2: +20000 ~ −20000

Note: The least significant digit of ℓ1 and ℓ2 are assumed as the least significant digit of OFFSET A/B. The least significant digit of MAG, LEVEL, and SPECT is 0.01 dB, that of PHA is 0.1 deg, and that of DLY is one thousandth of DELAY RANGE. When DLY EXP is on, however, values 1, 2 and 4 times these values are displayed by selecting DR (Delay Range) step (1, 2, 4).

(2) Data request message

OFR

5.2 MEASURE FUNCTION

5.2.1 LOG START/STOP FREQUENCY

(1) Control message

FLm1, m2 Sets frequencies. m1 and m2 indicate the LOG START and LOG STOP frequencies, respectively. (However, m1 < m2.)
FLm1 Sets the LOG START frequency.
FL, m2 Sets the LOG STOP frequency.

m1	m2	FREQUENCY
0	x	10 (Hz)
1	1	100
2	2	1K
3	3	10K
4	4	100K
5	5	1M
x	6	10M
x	7	30M

(2) Data request message

FLR

5.2.2 LIN START/STOP FREQUENCY

(1) Control message

FSℓ1, ℓ2 Sets frequencies. ℓ1 and ℓ2 indicate the START and STOP frequencies, respectively.
FSℓ1 Sets the START frequency.
FS, ℓ2 Sets the STOP frequency.

ℓ1 ≤ ℓ2
ℓ1, ℓ2: 0.00 ~ 30000000.00 Hz (in 0.25 Hz steps)

(2) Data request message

FSR

5.2.3 LIN CENTER/SPAN FREQUENCY

(1) Control message

FCℓ1, ℓ2 Sets frequencies. ℓ1 and ℓ2 indicate the CENTER and SPAN frequencies, respectively.
FCℓ1 Sets the CENTER frequency.
FC, ℓ2 Sets the SPAN frequency.

ℓ2 ≤ 2·ℓ1
ℓ1, ℓ2: 0.00 ~ 30000000.00 Hz (in 0.25 Hz steps)

(2) Data request message

FCR

5.2.4 FREQUENCY SETTING

(1) Control message

FPn Sets the frequency setting mode.

n	Setting mode
0	LOG START/STOP
1	START/STOP
2	CF/SPAN

(2) Data request message

FPR

5.2.5 OUTPUT (START)/STOP/STEP LEVEL

(1) Control message

LLℓ1, ℓ2, ℓ3 Sets output levels. ℓ1, ℓ2, and ℓ3 indicate the output levels of OUTPUT (START), STOP, and STEP, respectively.
LLℓ1 Sets the OUTPUT (START) level.
LL, ℓ2 Sets the STOP level.
LL, ℓ3 Sets the STEP level.

ℓ1, ℓ2, ℓ3: +15.00 ~ –110.00 (dBm or dB)

*Note: When **LEVEL SWEEP** is OFF, ℓ1 indicates the output level, and when **LEVEL SWEEP** is ON, ℓ1 indicates the start level.*

(2) Data request message

LLR

5.2.6 LEVEL SWEEP

(1) Control message

LWn Switches the LEVEL SWEEP function.

n	LEVEL SWEEP
0	OFF
1	ON

(2) Data request message

LWR

5.2.7 INPUT RANGE

(1) Control message

IRm Sets the INPUT RANGE value.

m	INPUT RANGE
0	–40 (dBm)
1	–30
2	–20
3	–10
4	0
5	+10
6	+20

(2) Data request message

IRR

5.2.8 DELAY RANGE

(1) Control message

DRm Sets the DELAY RANGE value.

m	DELAY RANGE
0	1 (μS)
1	2
2	4
3	10
4	20
5	40
6	100
7	200
8	400
9	1 (mS)
10	2
11	4
12	10
13	20
14	40
15	100
16	200
17	400

*Note: This message is executed only when TRACE is **DLY** or **M/D**.*

(2) Data request message

DRR

5.2.9 RES/VIDEO BW

(1) Control message

BWm1, m2 Sets the BW value. m1 and m2 indicate the values of RES BW and VIDEO BW respectively.
BWm1 Sets the RES BW value.
BW, m2 Sets the VIDEO BW value.

m1	m2	BW
x	0	1 (Hz)
1	1	3
2	2	10
3	3	30
4	4	100
5	5	300
6	6	1K
7	7	3K
8	8	10K
9	9	30K

*Note: This message is not executed when **COUPLED TO FREQ** or **COUPLED TO SPAN** is ON.*

(2) Data request message

BWR

5.2.10 SWEEP TIME

(1) Control message

STℓ Sets the SWEEP TIME value.

ℓ: 50 ~ 90000000 mS (The first two digits are significant.)

*Note: This message is not executed when **COUPLED TO FREQ** or **COUPLED TO SPAN** is ON.*

(2) Data request message

STR

5.2.11 IMPEDANCE R/T

(1) Control message

IMm1, m2 Switches input impedances. m1 and m2 indicate R-side and T-side input impedances, respectively.
IMm1 Switches the R-side input impedance.
IM, m2 Switches the T-side input impedance.

m1	m2	IMPEDANCE
0	0	*
1	1	1 MΩ

* MS420B: 75 Ω
MS420K: 50 Ω

(2) Data request message

IMR

5.2.12 OUTPUT A/B

(1) Control message

OPm Switches OUTPUT A/B.

m	OUTPUT
0	A
1	B

(2) Data request message

OPR

5.2.13 SIGNAL TRACK

(1) Control message

ATn Switches the SIGNAL TRACK status.

n	SIGNAL TRACK
0	OFF
1	ON

*Note: The SIGNAL TRACK is always OFF when the TRACE is not **LEVEL** or **SPECT**.*

(2) Data request message

ATR

5.2.14 COUPLED TO FREQ

(1) Control message

CFn, m Switches the COUPLED TO FREQ status.

n	COUPLED TO FREQ
0	OFF
1	ON

m	ST AUTO
0	x2
1	x1
2	x0.5
3	x0.2
4	x0.1

*Note: If **COUPLED TO FREQ** is set to OFF, m is reset to 1.*

(2) Data request message

CFR

5.2.15 COUPLED TO SPAN

(1) Control message

CPn Switches the COUPLED TO SPAN status.

n	COUPLED TO SPAN
0	OFF
1	ON

*Note: The COUPLED TO SPAN is always OFF when the TRACE is not **LEVEL** or **SPECT**.*

(2) Data request message

CPR

5.2.16 CAL X-S

(1) Control message

XSn Switches the X-S function.

n	X-S
0	OFF
1	ON

(2) Data request message

XSR

5.2.17 TRACK ADJ

(1) Control message

BTn, ℓ Switches the TRACK ADJ function and adjusts RBW tuning.

n	TRACK ADJ
0	OFF
1	ON

ℓ : 0 ~ 255 Sets the voltage for adjusting RBW tuning.
For details, refer to "TRACKING ADJUST" in paragraph 2.8-(29) in the MS420[ ] Network/Spectrum Analyzer Operation Manual.

(2) Data request message

BTR

5.2.18 UNCAL

(1) Control Message

None.

(2) Data request message

This function indicates the UNCAL lamp status.

UCR Data output from the MS420[ ] is 0 or 1.

0: NO UNCAL
1: UNCAL

5.2.19 OVER LOAD

(1) Control message

None.

(2) Data request message

This functions indicate the status of the OVER LOAD lamp.

OVR Data output from the MS420[ ] is 0, 1, 2 or 3.

0: NO OVER LOAD
1: R-side OVER LOAD
2: T-side OVER LOAD
3: R- and T-side OVER LOAD

Note: Execute OVER after activating SWEEP START.

5.3 CONTROL FUNCTION

5.3.1 SWEEP AUTO/MARKER

(1) Control message

AMn Switches AUTO/MARKER.

n	AUTO/MARKER
0	AUTO
1	MARKER

(2) Data request message

AMR

5.3.2 SWEEP STOP/RESET

(1) Control message

MEm Stops or resets the sweep.

m	STOP/RESET
0	STOP
1	RESET

(2) Data request message

MER Outputs the current sweep status with 0 or 1.

0: Sweep ended
1: Sweeping

Note: The end of sweeping can also be detected by a serial polling interrupt. For details, refer to "Sweep termination" in paragraph 6.3.1.

5.3.3 SWEEP REPEAT/SINGLE START

(1) Control message

MSm Activates sweep REPEAT START or SINGLE START.

m	SWEEP START
0	REPEAT
1	SINGLE

(2) Data request message

None.

5.3.4 PTA

(1) Control message

PTn Switches the PTA function.

n	PTA
0	OFF
1	ON

Note: When the PTA option is not incorporated in the MS420[ ], PTA is always OFF.

(2) Data request message

PTR

5.3.5 CAL INT

(1) Control message

IT Executes INTERNAL CAL once. If a sweep operation is under way, execution of this message is delayed until the sweep operation is terminated.

5.3.6 CAL X → S

(1) Control message

CS Executes CAL X → S.

(2) Data request message

None.

*Note: Termination of CAL X → S execution can be obtained by **MER** (data request message for sweep termination).*

5.3.7 SAVE

(1) Control message

SV m1, m2 Saves all MS420[ ] functions in internal memory or **PBMI**.

	m1	m2
REG	0	0 ~ 2
MEM	1	0 ~ 5

REG: Internal memory
MEM: Plug-in bubble memory (PBM)

*Note: Waits for five seconds or more when transmitting another device message after transmitting control message **SV1, m2**.*

(2) Data request message

None.

5.3.8 RECALL

(1) Control message 1

RCm1, m2 Recalls all MS420[ ] functions from internal memory or the PBMI and sets them to MS420[ ].

	m1	m2
REG	0	0 ~ 2
MEM	1	0 ~ 5

REG: Internal memory
MEM: Plug-in bubble memory (PBM)

*Note: Waits for five seconds or more when transmitting another device message after transmitting control message **RCI, m2**.*

(2) Control message 2

The following control functions exclusive of recalling the function memory.

RC 0, 3 : MKR → OFS
RC 0, 4 : ΔMKR → SPAN
RC 0, 5 : MKR → CF
RC 0, 6 : MKR → PEAK
RC 0, 9 : INIT

(3) Data request message

None.

5.3.9 INITIAL SET

(1) Control message

IN Sets all MS420[ ] functions to the initial power-on. See APPENDIX 3 FRONT PANEL STATUS AT POWER ON.

(2) Data request message

None.

5.3.10 BREAK POINT

The MS420[ ] ordinarily measures 251 points, and higher measurement rates are available by decreasing the number of measurement points by setting a break point. The measurement area is from point 0 to the specified point. For details, see "Program for Rapid Measurement by Decreasing Measurement Points" in paragraph 8.4.

(1) Control message

BPℓ Sets a break point.

ℓ: 1 ~ 251 (If ℓ is set from 252 to 255, ordinary measurement is done.)

(2) Data request message

BPR

5.4 ADV FUNCTION

5.4.1 INTEGRATING

(1) Control message

IGn Switches the INTEGRATING function.

n	INTEGRATING
0	OFF
1	ON

(2) Data request message

IGR

5.4.2 MAX. HOLD

(1) Control message

MHn Switches the MAX. HOLD function.

n	MAX. HOLD
0	OFF
1	ON

*Note: The MAX. HOLD function is always OFF when the TRACE is not **LEVEL** or **SPECT**.*

(2) Data request message

MHR

5.4.3 FREQUENCY COUNT

(1) Control message

FOn Switches the FREQUENCY COUNT function.

n	FREQUENCY COUNT
0	OFF
1	ON

*Note: The FREQUENCY COUNT function is always OFF when the TRACE is not **LEVEL** or **SPECT**.*

(2) Data request message

FOR

(3) Data request message for measurement results of FREQUENCY COUNT and the marker readout frequency.

MFR

Note: Since FREQUENCY COUNT operation is executed after sweep operation is terminated, wait for about 1.5 second after sweep termination before reading the data.

5.4.4 SWEEP MARKER

(1) Control message

SMn Switches the SWEEP MARKER function.

n	SWEEP MARKER
0	OFF
1	ON

(2) Data request message

SMR

5.4.5 BUZZER

(1) Control message

BZn Switches the BUZZER function.

n	BUZZER
0	OFF
1	ON

(2) Data request message

BZR

5.4.6 AUTO CAL. TIMER

(1) Control message

CTℓ Switches the AUTO CAL. TIMER function and sets the timer.

ℓ: 0 ~ 99 minute (If ℓ is 0, the AUTO CAL. TIMER is set to OFF.)

*Note: Although TIMER = 0 when the power is turned ON, **INTERNAL CAL.** is executed once about 15 minutes after power on.*

(2) Data request message

CTR

5.4.7 TITLE

(1) Control message

TT, abcdef, Displays title data of up to 15 characters delimited by two commas (, ,). In this example, "abcdef" is the title.

TT, , Clears title data.

(2) Data request message

TTR

5.4.8 SRQ

(1) Control message

SQn Switches the SRQ function.

n	SRQ
0	OFF
1	ON

*Note: SRQ is OFF at power on. For details on SRQ, refer to SECTION 6 INTERRUPT, and "**SRQ** command" in paragraph 7.1.2.*

(2) Data request message

SQR

5.4.9 DELIMIT

(1) Control message

DMn Switches the DELIMIT function.

n	DELIMIT
0	OFF
1	ON

Note: DELIMIT is OFF at power on. For details on DELIMIT, refer to "DLI command" in paragraph 7.1.3.

(2) Data request message

DMR

5.4.10 SEND

(1) Control message

None.

(2) Data request message

SDR One character of SEND status is output from the MS420[ ].

Note: For details on SEND status, refer to "SEND" in paragraph 6.3.2 and "SND command" in paragraph 7.1.4.

5.5 Measurement Memory

The MS420[ ] has frequency memory, level memory, measurement and S memories for channel A/B, each with a capacity of 251 points. For details, refer to "Measurement memory system" in paragraph 5.5.8.

5.5.1 Frequency memory

If a measurement frequency range is input to the MS420[ ] by LOG START/STOP, START/STOP, or CENTER/SPAN, each frequency is stored in frequency memory, with a capacity of 251 points. The frequency at a specific measurement point can be updated or read out of the frequency memory.

(1) Control message

FQℓ Specifies the address of the frequency memory. ℓ is an integer from 0 to 250 indicating the measurement point.

• Program example

This program sets the frequencies of measurement points 150 to 159 in 1 kHz steps starting from 5 kHz.

```
10 WRITE @101:"FQ150"  – Specifies the address of frequency memory.
20 LET FREQUENCY=5000  – Specifies frequency 5 kHz.
30 FOR I=150 TO 159    – Specifies repetition of setting frequency range from point 150
                         to 159.
40 WRITE @101 USING "A":FREQUENCY – Specifies frequency setting.
```

Note: 1. FREQUENCY: 0.00 ~ 30000000.00 Hz
2. Increments the frequency memory address.
3. USING "A" is an instruction to transfer values in a format with an automatic number of significant digits.

```
50 LET FREQUENCY=FREQUENCY+1000 – Specifies 1 kHz increment.
60 NEXT I
```

Note: 1. If a new frequency is set by LOG START/STOP, START/STOP, or CENTER/SPAN after execution of this control message, the previous frequency stored in the frequency memory is replaced by the new value.
2. If this control message is executed after the frequency is set by LOG START/STOP, START/STOP, or CENTER/SPAN, start execution after one or more seconds has elapsed.

(2) Data request message

FQR ℓ1, ℓ2 The MS420[ ] transmits the frequency data of ℓ2 points starting from point ℓ1.
ℓ2 = 251 – ℓ1

• Program example

```
10 DIM F(251)
20 WRITE @101:"FQR0,251" –Requests the frequency data from point 0 to 250.
30 FOR I=0 TO 250
40 READ @101:F(I) ————— Reads the frequency data of 251 points from the MS420[ ].
50 NEXT I
```

5.5.2 Output level memory

The MS420[ ] has an output level memory with a capacity of 251 points. If an output level is input by START, STOP, or STEP, it is stored in this output level memory. The output level at a specific measurement point can be updated or read out of output level memory.

(1) Control message

LVℓ Specifies the address of level memory. ℓ is an integer from 0 to 250, and indicates the measurement point.

• Program example

Setting the output level of measurement point 10 to 13 in 0.02 dB steps starting from −20 dBm.

```
10 WRITE @101:"LV10" ————————— Specifies the level memory address.
20 LET LEVEL=-20 ——————————— Specifies level −20 dBm.
30 FOR I=10 TO 13 ————————— Specifies repetition of output level setting from
                              point 10 to 13.
40 WRITE @101 USING "A":LEVEL — Specifies output level setting.
```

Note: 1. LEVEL: −110 ~ +15 dBm
2. Increments the output level memory address.

```
50 LET LEVEL=LEVEL+.02
60 NEXT I
70 END
```

Note: 1. If a new output level is set by START, STOP, or STEP after execution of this control message, the previous output level stored in the output level memory is replaced by the new value.
2. If this control message is to be executed after the output level is set by START, STOP, or STEP, it must be started after at least one second has elapsed.

(2) Data request message

LVRℓ1, ℓ2 The MS420[ ] transmits 12 points of level starting from point ℓ1.

ℓ2 = 251 − ℓ1

• Program example

```
10 DIM L(251)
20 WRITE @101:"LVR0,251" — Requests output level data of point 0 to 250.
30 FOR I=0 TO 250
40 READ @101:L(I) ————— Reads output level data of 251 points from MS420[ ].
50 NEXT I
60 END
```

5.5.3 Measurement memory for channel A

Measurement results of the following TRACE functions are stored in measurement memory for channel A:

(a) All **TRACE** during 1 channel measurement

(b) **MAG** during 2 channel measurement

Data in this memory can be updated by personal computer. When SWEEP is started, however, the measurement results replace the data.

(1) Control message

XAℓ Sets the measurement memory address for channel A. ℓ is an integer from 0 to 250 indicating the measurement point.

*Note: Data transmitted after XA*ℓ *is integer type, and least significant digit is the minimum measurement resolution.*

(2) Data request message

XARℓ1, ℓ2 The MS420[ ] transmits ℓ2 points of measurement results of channel A starting from point ℓ1.

Note: Data transmitted by MS420[ ] is integer type, and least significant digit is the minimum measurement resolution.

• Program example

SWEEP SINGLE START is specified for the MS420[ ], and when SWEEP is terminated, all MAG measurement results are read, converted to MAG resolution, and stored into variable MAG (I).

```
10 DIM MAG(251) ————————— Register the same number of variable areas as the number
                           of measurement points.
20 WRITE @101:"TR0" ————— Set TRACE FUNCTION to MAG
30 WRITE @101:"MS1" ————— SINGLE START
40 WAIT DELAY .3
50 WRITE @101:"MER" ————— Request SWEEP STATUS
60 READ @101:ME ————————— Read SWEEP STATUS
70 IF ME=1 THEN 40 ————— Wait for until SWEEP terminates
80 WRITE @101:"XAR0,251" — Request measurement results.
90 FOR I=0 TO 250
100 READ @101:MAG(I) ———— Read measurement results
110 LET MAG(I)=MAG(I)*.01 — Convert to MAG measurement resolution
120 NEXT I
130 END
```

5.5.4 Measurement memory for channel B

Measurement results of the following TRACE functions are stored in the channel B measurement memory:

(a) P(PHA) or D(DLY) during 2 channel measurement **(M/P** or **M/D)**

(b) **SUB TRACE**

Data in this memory can also be updated by personal computer. When SWEEP is started when **SUB TRACE** is **B=A**, however, measurement results replace the data.

(1) Control message

XBℓ Sets the address of the measurement memory for channel B. ℓ is an integer from 0 to 250 indicating the measurement point.

Note: Same as 5.5.3 (1).

(2) Data request message

XBRℓ**1, **ℓ**2** The MS420[ ] transmits ℓ2 points of measurement results of channel B starting from point ℓ1.

Note: Same as 5.5.3 (2).

- Program example

This program reads measurement results of MAG and PHA from point 100 to 200, converts them to MAG and PHA resolutions, and stores the results into variable MAG(I) and PHA(I).

```
10 DIM MAG(251),PHA(251) ——— Register variable area
20 WRITE @101:"XAR100,101" — Request MAG measurement results
30 FOR I=100 TO 200
40 READ @101:MAG(I) ———————— Read MAG measurement results
50 LET MAG(I)=MAG(I)*.01 ——— Convert to MAG measurement resolution
60 NEXT I
70 WRITE @101:"XBR100,101" — Request PHA measurement results
80 FOR I=100 TO 200
90 READ @101:PHA(I) ———————— Read PHA measurement results
100 LET PHA(I)=PHA(I)*.1 ——— Convert to PHA measurement resolution
110 NEXT I
120 END
```

5.5.5 S memory for channel A

Measurement results of channel A are stored in S memory by **CAL X→S**. Data in S memory can also be updated by personal computer source. When **CAL X→S** is executed, however, channel A measurement results replace the data.

(1) Control message

SAℓ Sets the address of S memory for channel A. ℓ is an integer from 0 to 250 indicating the measurement point.

Note: Same as 5.5.3 (1).

(2) Data request message

SARℓ1, ℓ2 The MS420[ ] transmits. ℓ2 points of data stored in the S memory for channel A starting from point ℓ1.

Note: Same as 5.5.3 (2).

5.5.6 S memory for channel B

Measurement results of channel B are stored in S memory for channel B. Datas in this memory can also be updated by personal computer. When **CAL X→S** is executed, however, channel B measurement results replace the data.

(1) Control message

SBℓ Sets the address of S memory for channel B. ℓ is an integer from 0 to 250 indicating the measurement point.

Note: Same as 5.5.3 (1).

(2) Data request message

SBRℓ1, ℓ2 The MS420[ ] transmits ℓ2 points of data stored in the S memory for channel B starting from point ℓ1.

Note: Same as 5.5.3 (2).

5.5.7 Reading measurement results

The data read methods explained in paragraph 5.5.3 and 5.5.4 read integer data on one channel.
Another data read method is presented in this section.

(1) Control message

None.

(2) Data request message

Transmits data stored in measurement memory in the measurement format, that is, in the digital display format (measurement results display at marker point).

MMRℓ1, ℓ2 The MS420[ ] transmits ℓ2 points of measurement data starting from point ℓ1 in the measurement format.

MMR Transmits data at the marker point.

Measurement value at the marker point of channel A or channel A/B. For ZERO or ΔMARKER, however, the measurement value obtained at ZERO or MARKER is assumed.

(a) Measurement by one channel

Measurement format	Reading format
−10.12 dBm	−10.12 CRLF
0.10 dB	0.1 CRLF
150.3 deg	150.3 CRLF
20.0 μS	20 CRLF

(b) Measurement by two channels

Measurement data of channels A and B is transmitted alternately in the format as shown in the table in 5.5.7 (a).

- Program example 1

This program reads the measurement results when TRACE is M/P and **DELIMIT** is **OFF**.

```
10 DIM MAG(250),PHA(250) ———————— Register variable area
20 WRITE @101:"DM0" ———————————— DELIMIT OFF
30 WRITE @101:"MMR0,251" ———————— Request measurement data
40 FOR I=0 TO 250
50 READ @101:MAG(I)¥READ @101:PHA(I) — Read measurement data
60 NEXT I
70 END
```

Note: The delimiter for MAG and PHA data is (CR) (LF).

- Program example 2

This program reads the measurement results when TRACE is M/P and **DELIMIT** is **ON**.

```
10 DIM MAG(250),PHA(250) —— Register variable areas
20 SEPARATER IS ";" ————— Set delimiter (;)
30 WRITE @101:"DM1" ————— Set DELIMIT to ON
40 WRITE @101:"MMR0,251" —— Request measurement data
50 FOR I=0 TO 250
60 READ @101:MAG(I),PHA(I) — Read measurement data
70 NEXT I
80 END
```

Note 1: The delimiter for MAG and PHA data is a semicolon (;).

−34.56 (MAG) ; 156.7 (PHA) (CR)(LF)

Note 2: Data length is fixed.
Examples at MAG, LEVEL, or SPECT.

−100, 12 (CR)(LF)
−Δ10, 12 (CR)(LF)
ΔΔΔ1, 23 (CR)(LF)

Δ : Space

(c) Reading marker data

- Program example 1

This program reads marker data measured by MAG.

```
10 WRITE @101:"MMR" — Request marker data
20 READ @101:MAG —— Read the value measured at the marker point by MAG.
30 END
```

- Program example 2

In this example, TRACE is set to LEVEL(T) and the frequency and level of the 10 MHz input signal are measured and stored in the FREQUENCY and LEVEL variable areas.

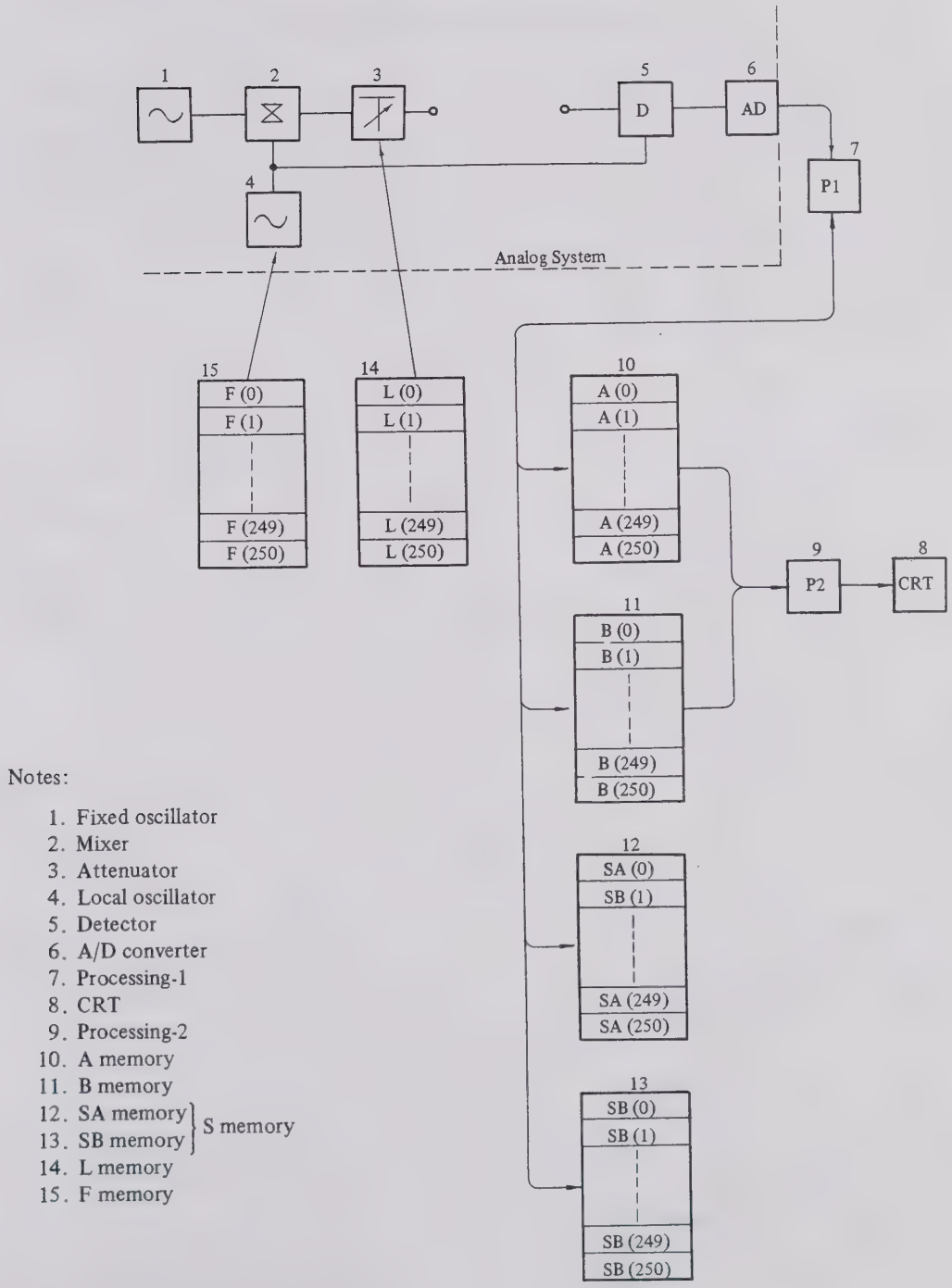
```
10 DIM LEVEL(250) ———————————— Register a work area
20 WRITE @101:"TR4" ———————————— Set TRACE to LEVEL(T)
30 WRITE @101:"FC10000000,100000F01" — Set CENTER=10MHz, SPAN=100kHz,
                                       and FREQUENCY COUNT to ON
40 WRITE @101:"MS1" ———————————— SWEEP START
50 WAIT DELAY .3
60 WRITE @101:"MER"
70 READ @101:ME ———————————— Wait for SWEEP termination
80 IF ME=1 THEN 60
90 LET MAX=-200
100 WRITE @101:"MMR0,251" ———————— Request level measurement data
110 FOR I=0 TO 250
120 READ @101:LEVEL(I) ———————— Read measurement data
130 IF MAX>LEVEL(I) THEN 150 ———— Obtain input level
140 LET MAX=LEVEL(I)
150 NEXT I
160 WRITE @101:"MFR" ———————————— Request the FREQUENCY COUNT
                                    results
170 READ @101:FREQUENCY ———————— Read the input signal frequency
180 END
```

5.5.8 MEMORY SYSTEM

The MS420A[ ] performs measurements on the basis of arrayed configuration memory. Descriptions are loaded in this memory system as described below.

Figure 5-1 shows how this system is connected to an analog system. The flow of measurements based on this figure is shown in Figure 5-2. The X values (measured values at each point) in the figure are stored in memories A, B, SA, and SB through the flow shown in Table 5-1. P2 processing as shown in the table is the adjustment of SCALE and OFFSET.

Figure 5-3 shows the operating functions for these memories. This figure shows how to control an element of each memory by peripheral units. For example, if the GP-IB and PTA option are used, it means that all memories can be operated freely.



Notes:

1. Fixed oscillator
2. Mixer
3. Attenuator
4. Local oscillator
5. Detector
6. A/D converter
7. Processing-1
8. CRT
9. Processing-2
10. A memory
11. B memory
12. SA memory } S memory
13. SB memory }
14. L memory
15. F memory

Fig. 5-1 Connection Between Memory System and Analog System

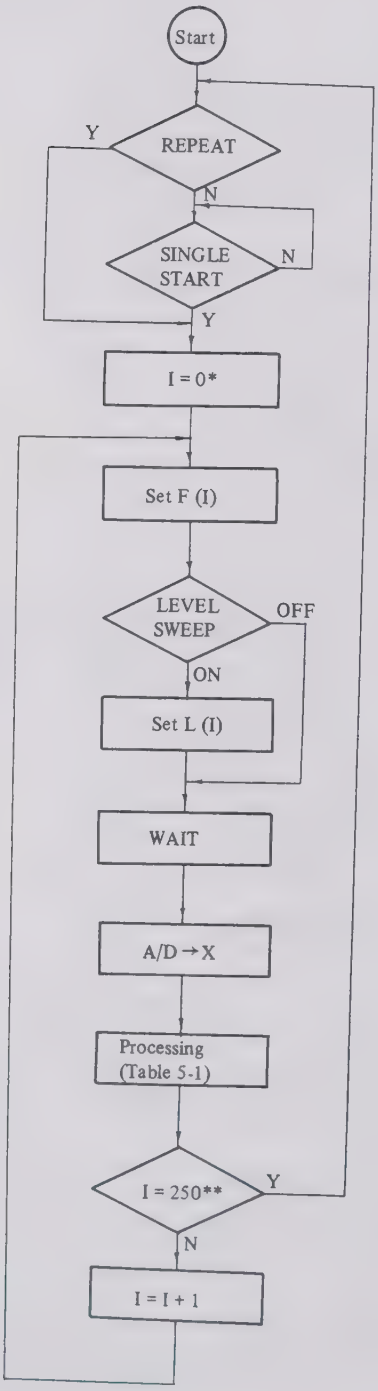


Fig. 5-2 Measurement Flowchart

Note

1. For marker sweep operation, * and ** become the value at the marker point.
2. For Δmarker sweep operation, * and ** are the start and stop points, respectively.

Table 5-1 Measurement Data Processing

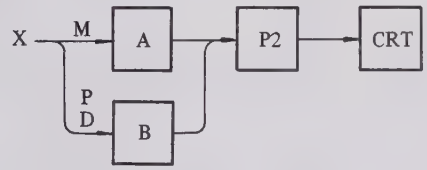
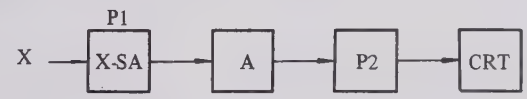
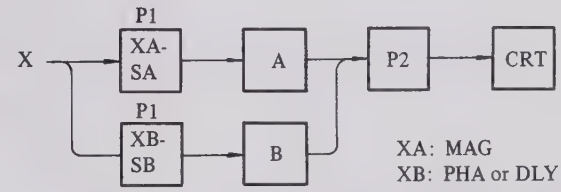
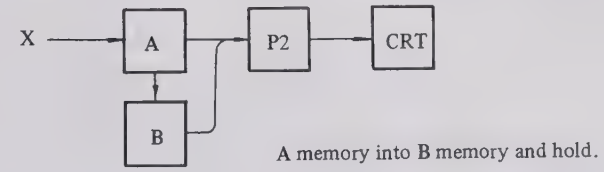
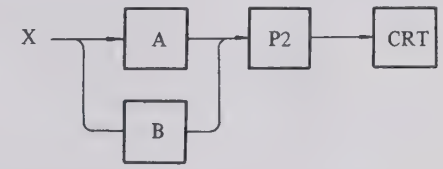
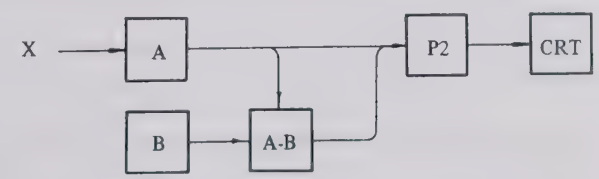
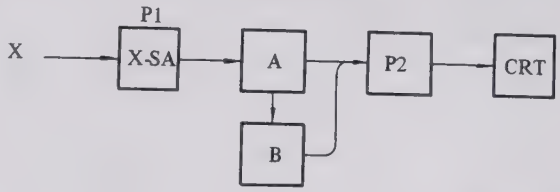
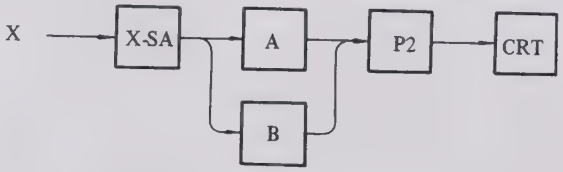
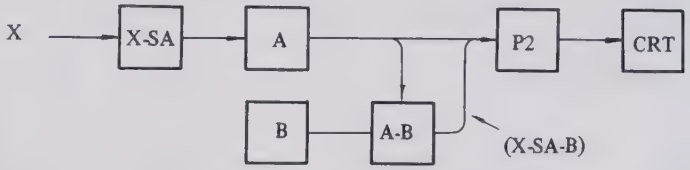
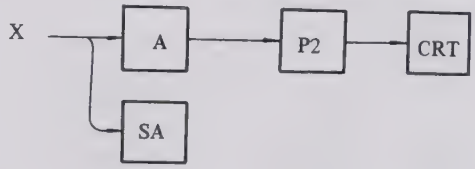
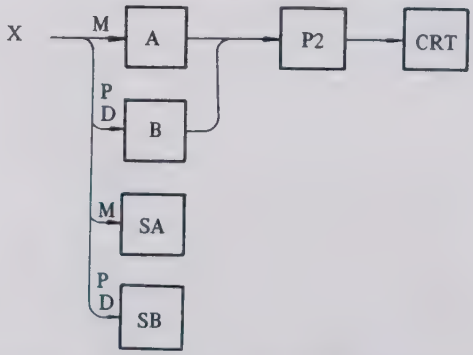
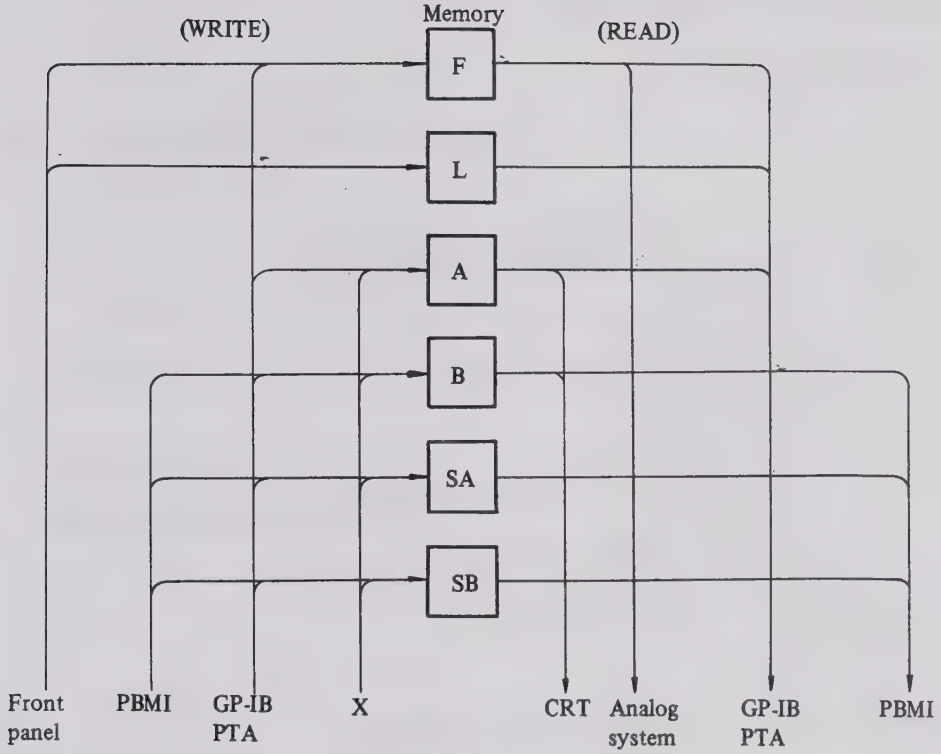
Functions			Data flow
MAG, PHS, DLY, LEVEL, SPECT X-S; OFF SUB TRACE: OFF			
M/P, M/D X-S; OFF SUB TRACE: OFF			
MAG, PHS, DLY, LEVEL, SPECT X-S; ON SUB TRACE: OFF			
M/P, M/D X-S; ON SUB TRACE: OFF			
MAG PHS DLY LEVEL SPECT SUB TRACE : ON	X-S: OFF	A→B	
		B = A	
		B = A – B	

Table 5-1 Measurement Data Processing (Cont'd)

Functions			Data flow
MAG PHS DLY LEVEL SPECT SUB TRACE: ON	X-S: ON	A → B	
		B = A	
		B = A – B	
MAG, PHS, DLY, LEVEL, SPECT One sweep after pressing the [X → S] key.			
M/P, M/D One sweep after pressing the [X → S] key.			



Variable name

	GP-IB	PTA
F	FQ, FQR, MMR	F
L	LV, LVR, MMR	L
A	XA, XAR	XA
B	XB, XBR	XB
SA	SA, SAR	XSA
SB	SB, SBR	XSB

Fig. 5-3 Memory System Control

5.6 Device Messages on CRT Coordinates

The CRT can be controlled as a terminal by a personal computer with three types of device messages; display delete, character display, and graphic display.

5.6.1 Display delete message

Display delete messages are used to clear or restore the display in measurement mode (when power is on).

CRm

m	Functions
0	Clears the CRT
1	Restores display line 1
2	Restores display line 2
3	Restores display line 3
4	Restores display line 4
5	Restores display line 5
6	Restores display line 6
7	Restores the measurement graph and sweep marker
8	Restores the scale
9	Performs all functions for m=0 to 8 above

Note: Refer to paragraph 5.6.4 for details.

5.6.2 Character display message

Displays characters at the specified screen position, in various modes.

CCm, X, Y, abcd,

m	CRT mode
0	Characters are displayed high intensity in normal mode (not reversed)
1	Characters are displayed high intensity in reverse mode
2	Characters are displayed low intensity in normal mode (not reversed)
3	Characters are displayed low intensity in reverse mode

X: Integer (0 to 254) indicating a position on the X-axis of the CRT.
Y: Integer (0 to 216) indicating a position on the Y-axis of the CRT.
abcd: Characters to be displayed (up to 42 characters)

Note: The characters are actually displayed at positions X+1 and Y+1. For details, refer to "CRT coordinate" in paragraph 5.6.4.

5.6.3 Graphic display message

A line can be drawn from a specified start point to an end point by linear interpolation.

CGm, X1, Y1, X2, Y2

m	CRT mode
0	A line is drawn on a high intensity screen
1	A line is drawn on a low intensity screen

X1: Integer (0 to 254) indicating a position on the X-axis
Y1: Integer (0 to 216) indicating a position on the Y-axis
X2: Integer (0 to 254) indicating the position on the X-axis
Y2: Integer (0 to 216) indicating the position on the Y-axis

Note: For details on the CRT screen, refer to "CRT coordinate" in paragraph 5.6.4.

5.6.4 CRT coordinate

The Fig. 5-4 shows a CRT coordinate of MS420[ ].

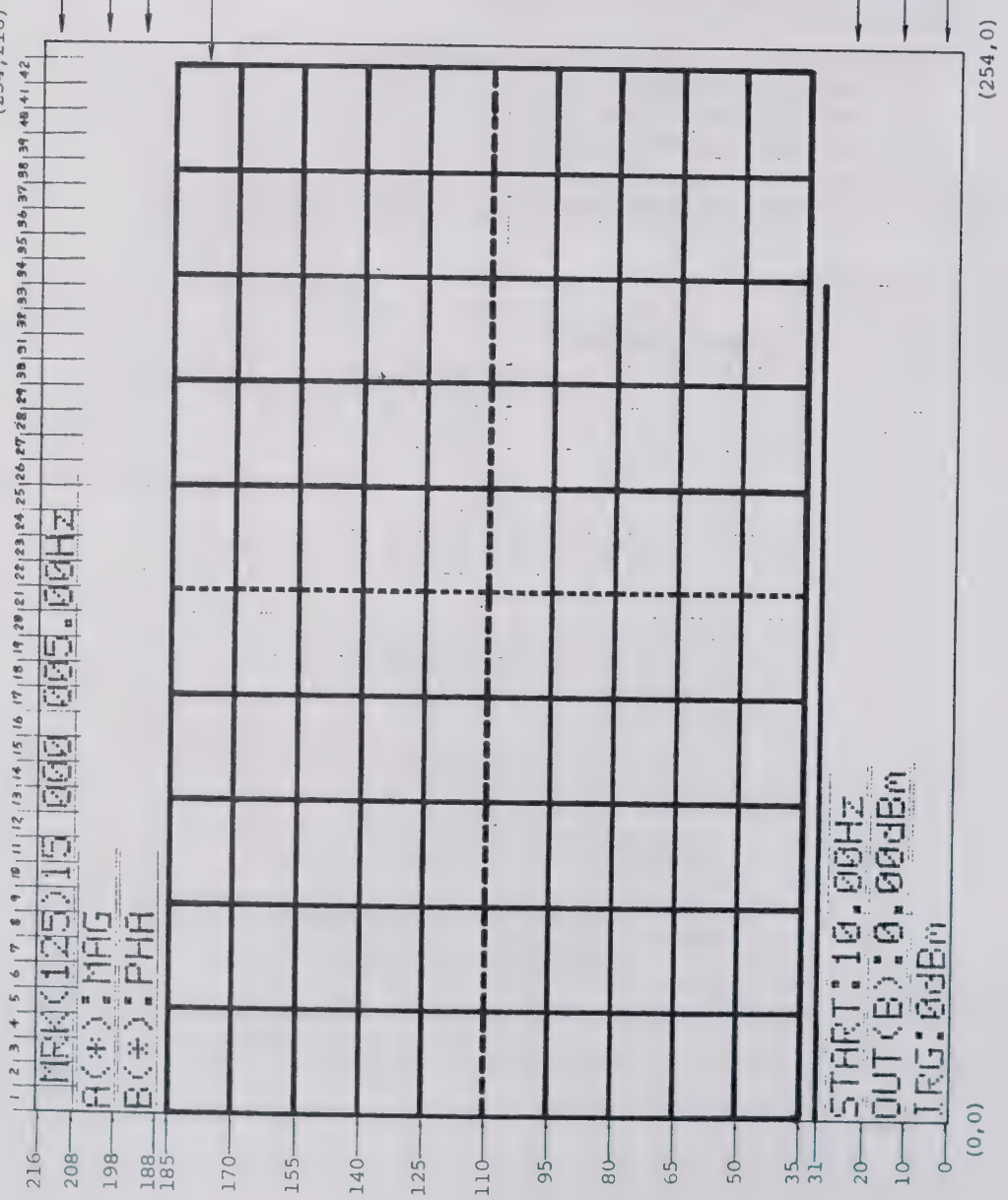


Fig. 5-4 CRT Coordinate

5.6.5 Program example for CRT control

In this example, the lines for the object to be measured are drawn on the low intensity screen, display line 6 is deleted, **MS420A NET. ANALYZER** is displayed on the left half of the line, and **Anritsu** is displayed on the right half in reverse mode.

```
10 WRITE @101:"CR0"
20 FOR M=0 TO 5
30 WRITE @101 USING "C,A":"CR",M
40 NEXT M
50 WRITE @101:"CR7"
60 WRITE @101:"CR8"
70 WRITE @101:"CC0,0,0,MS420A NET.ANALYZER,"
80 WRITE @101:"CC1,125,0,Anritsu,"
90 WRITE @101:"CG1,0,70,70,70"
100 WRITE @101:"CG1,70,70,70,160"
110 WRITE @101:"CG1,70,160,180,160"
120 WRITE @101:"CG1,180,160,250,70"
130 WRITE @101:"CG1,90,35,90,130"
140 WRITE @101:"CG1,90,130,160,130"
150 WRITE @101:"CG1,160,130,160,35"
160 END
```

- Clear the screen
- Restore display lines 1 to 5
- Restore the measurement graph
- Restore the scale
- Display **MS420A NET. ANALYZER** on the left half of display line 6
- Display **Anritsu** on the right half of the display line, in reverse mode
- Draw the upper limit line
- Draw the lower limit line

Note: The USING "C, A" instruction transfers characters and values with the automatic number of significant digits format.

SECTION 6 INTERRUPT

The GP-IB interface enables the talker or listener to interrupt the controller. This interrupt is activated when the talker or listener issues an **SRQ** signal. Then, the controller determines which talker or listener is the source of the interrupt. This procedure is referred to as polling.

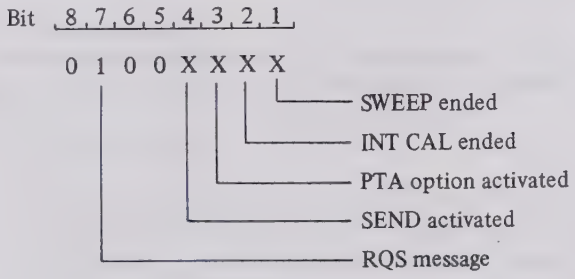
There are two types of pollings serial and parallel. The MS420[ ] uses the serial polling function.

6.1 Serial Polling

Serial polling is a procedure to determine from which talker or listener the SRQ signal was issued. The talker or listener which issued the SRQ signal sets bit 7 (RQS message) in its status byte. Other bits indicate the status under which the SRQ signal was issued. The MS420[ ] gets this status byte from each talker and listener and determines which talker or listener issued the SRQ signal.

6.2 Status Byte

The configuration of the status byte is as follows.



*Note: The interrupt is not generated when the **SRQ** of the **ADV** function is not ON, except for SEND activation. This **SRQ** is OFF when power is turned on. If serial polling is done when **SRQ** is OFF, the RQS message bit of the status byte is output 0.*

6.3 Example

6.3.1 SWEEP ended

SRQ is generated when the sweep operation ends, that is, when the SWEEP MARKER disappears. If the sweep operation is terminated by SWEEP STOP/RESET, however, the SRQ is not generated.

When the SRQ of the **ADV** function is OFF, the SRQ for sweep termination is not generated.

- Program example

In this example, MAG measurement results are read when the SRQ for SWEEP termination is generated.

```
10 COM MAG(250)                    ——— Register a variable area
20 WRITE @101:"SQ1"                ——— Set SRQ to ON
30 PROCESS EVENT GPIB"@01,02"      — Assert the SRQ event
40 START GPIBSRQ                   ——— Process GPIBSRQ when SRQ is generated
50 CONNECT EVENT GPIB              ——— Set a status under which an SRQ interrupt is enabled
 :
900 END
1000 PARACT GPIBSRQ URGENCY 30

1010 COM MAG(250)
1020 WAIT EVENT GPIB               ——— Read the MS420[ ] status byte and store it in A
1030 STATUS @101:A                 ——— IF A=65 (SWEEP ended), perform operation of program
                                       number 2000 and later
1040 IF A=65 THEN 2000
 :
1100 GO TO 1020
2000 WRITE @101 "MMR0,251"         ——— Request measurement results
2010 FOR I=0 TO 250
2020 READ @101:MAG(I)              ——— Read measurement results
2030 NEXT I
2040 GO TO 1020
2050 END PARACT
```

6.3.2 SEND

The front panel keys of the MS420[ ] can be used as a terminal for a personal computer.

With the **ADV** function, the MS420[ ] can exchange the data to the personal computer by generating a SRQ for SEND function. For details, refer to "SND command" in paragraph 7.1.4.

6.3.3 PTA

Refer to the PTA Option Operation Manual.

SECTION 7 ADV FUNCTION OF GP-IB

GP-IB commands, DATA OUT, WRITE, and READ commands are available as GP-IB control functions for the **ADV** function of the MS420[ ] Network/Spectrum Analyzer.

7.1 GP-IB Commands

There are four GP-IB commands: **ADR, DLI, SRQ,** and **SND.**

A GP-IB command is set by calling ADV line 10.

Press [BEGIN] [/] [1] [0] [EOL] in this order. The following appears on display line 6.

```
10 GP-IB COMMAND
```

7.1.1 ADR command

With the GP-IB COMMAND of the **ADV** function, the MS420[ ] can confirm and modify GP-IB addresses. For details, refer to "Modifying GP-IB Addresses with Front Panel Keys" in paragraph 3.3.

7.1.2 SRQ command

With this command, the MS420[ ] can switch the function for generating interrupt.

(1) Confirming SRQ

Press [S] [R] [Q] [?] [EOL] in this order. The following is displayed at the bottom of the screen, from which the SRQ status can be confirmed.

```
        GP-IB SRQ OFF
10 GP-IB COMMAND      SRQ?
```

(2) Switching SRQ

Press [S] [R] [Q] [1] (or [0]) [EOL] in this order. The following appears at the bottom of the screen, and the SRQ can be switched.

```
        GP-IB SRQ ON
10 GP-IB COMMAND      SRQ1
```

or

```
        GP-IB SRQ OFF
10 GP-IB COMMAND      SRQ0
```

Note: An UNDEFINED ERROR appears when the MS420[ ] is a controller.
This is OFF at power-up.

7.1.3 DLI command

The MS420[ ] uses delimiters to separate output data. For details, refer to "Reading measurement results" in paragraph 5.5.7 and "DATA OUT" in paragraph 7.2.

(1) Confirming DLI

Press [D] [L] [I] [?] [EOL] in this order. The following appears at the bottom of the screen, and the DLI status can be confirmed.

```
          GP-IB DELIMIT OFF
10 GP-IB COMMAND        DLI?
```

(2) Switching DLI

Press [D] [L] [I] [1] (or [0]) [EOL] in this order. The following is displayed at the bottom of the screen, and the DLI can be switched.

```
          GP-IB DELIMIT ON
10 GP-IB COMMAND        DLI1
```

Note: This is OFF at power-on.

7.1.4 SND command

The front panel keys of the MS420[ ] can be used as a terminal for a personal computer. The SRQ is generated by the **SND** command, an interrupt is generated for the personal computer, and keyed-in data is transmitted in ASCII code.

Press [S] [N] [D] [□] [EOL] in this order. The following appears on the bottom of the screen and SRQ is generated. (□ indicates a front panel key of the MS420[ ]).

```
10 GP-IB COMMAND        SND□‾‾‾‾  Data read by the SDR (data request command)
```

Upon receiving the SRQ, the personal computer performs serial polling, confirms the status byte of the SND command, and reads the keyed-in data from the MS420[ ] with the data request command (SDR).

Note: The SRQ by the SND command can be generated although the SRQ explained in "SRQ command" in paragraph 7.1.2 is OFF.

7.2 DATA OUT (Printing out Measurement Results)

With the **DATA OUT** of the **ADV** function, the MS420[ ] can output measurement results to a printer on the GP-IB.

12 DATA OUT #1, 200, 5 ; EOL

- GP-IB address of the printer
- Measurement point from which output is to start
- Number of measurement points to be output
- Immediate execution command (a colon (:) can also be used)

- If m1 and m2 are omitted, measurement results at the marker point are output.
- If the immediate execution command (; or :) is omitted, measurement results are output whenever a sweep operation is terminated.

(1) The following is output when **DLI** is **ON**.

```
200  21409000.00Hz  -58.95dB    -7.6ms
201  21409120.00Hz  -60.58dB    -1.6ms
202  21409240.00Hz  -61.38dB    17.6ms
203  21409360.00Hz  -63.29dB     2.4ms
204  21409480.00Hz  -64.89dB    -0.4ms
```

(2) The following is output when **DLI** is **OFF**.

```
200
21409000.00Hz
-58.95dB
-7.6ms
201
21409120.00Hz
-60.58dB
-1.6ms
202
21409240.00Hz
-61.38dB
17.6ms
203
21409360.00Hz
-63.29dB
2.4ms
204
21409480.00Hz
-64.89dB
-0.4ms
```

*Note: The MS420[ ] must be set as a controller. For details, refer to "Procedure for controller setting" in paragraph 3.3.3. For **DLI**, refer to "**DLI** command" in paragraph 7.1.3.*

7.3 WRITE

With the **WRITE** of the **ADV** function, the MS420[ ] can handle offset tracking with an external synthesizer and can control external devices. For details on external synthesizer offset tracking, refer to "Frequency Offset Measurement" in paragraph 3.6.4 of the MS420[ ] Network/Spectrum Analyzer Operation Manual.

```
11 WRITE        #1, "FQ12.3MZ"
```

FQ12.3MZ(CR)(LF) is transferred to the device with address 1 in immediate execution.

7.4 READ

With the **READ** of the **ADV** function, the MS420[ ] can read the status and measurement results of an external device and display them on the screen.

```
-123.45
13 READ         #2
```

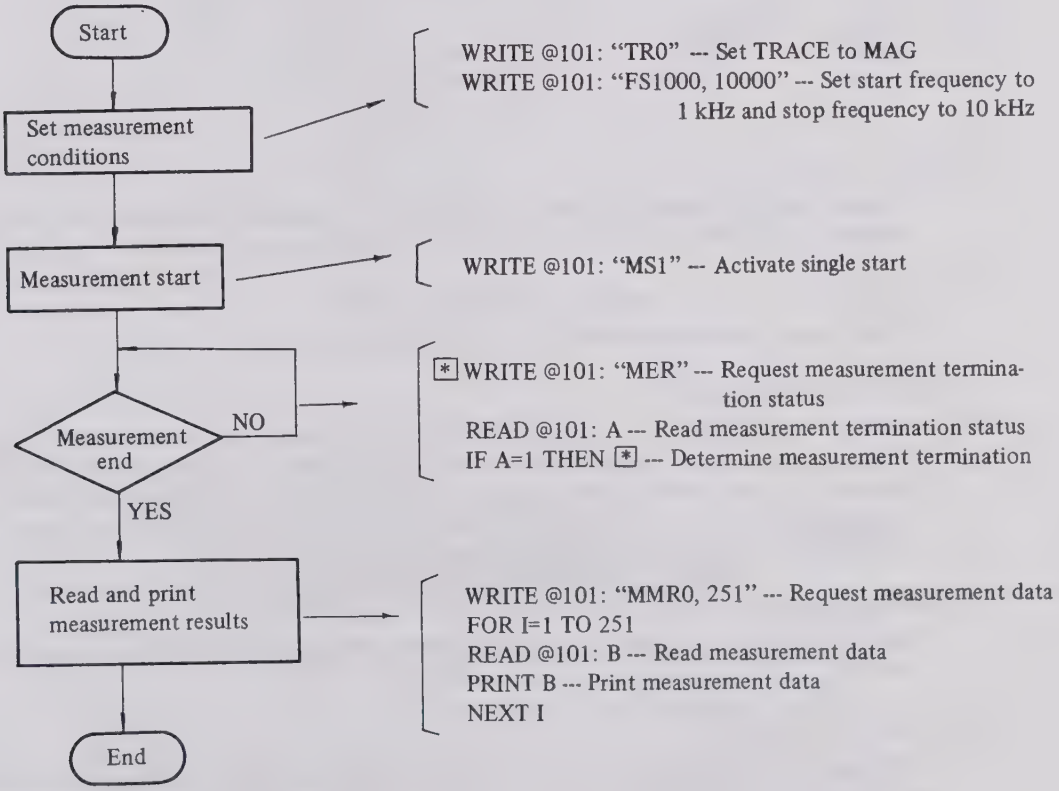
Data is read from the device at address 2 and displayed on the screen in immediate execution. Up to 41 characters of data can be read.

SECTION 8 PROGRAM EXAMPLES

Some example programs for controlling the MS420[ ] Network/Spectrum Analyzer with a Packet II Hy personal computer produced by ANRITSU and some remarks on programming techniques are given in this section.

8.1 General

The following description is a flowchart and program for controlling the MS420[ ] by Packet II.


Start
Set measurement conditions
WRITE @101: "TR0" --- Set TRACE to MAG
WRITE @101: "FS1000, 10000" --- Set start frequency to 1 kHz and stop frequency to 10 kHz
Measurement start
WRITE @101: "MS1" --- Activate single start
Measurement end
NO
YES
[*] WRITE @101: "MER" --- Request measurement termination status
READ @101: A --- Read measurement termination status
IF A=1 THEN [*] --- Determine measurement termination
Read and print measurement results
WRITE @101: "MMR0, 251" --- Request measurement data
FOR I=1 TO 251
READ @101: B --- Read measurement data
PRINT B --- Print measurement data
NEXT I
End

8.2 Programming Techniques

Note the following writing programs for MS420[ ] Network/Spectrum Analyzer control.

```
 10 WRITE @101:"IN"
 20 WAIT DELAY 1
 30 WRITE @101:"ME0CT0IT"
 40 WAIT DELAY 7
  :
100 WRITE @101:"MS1"
110 WAIT DELAY .05
120 WRITE @101:"MER"
130 READ @101:ME
140 IF ME=1 THEN 120
150 WRITE @101:"MMR0,251"
  :
```

10 WRITE @101: "IN"

Turn the MS420[ ] power on. Initialize all functions to power on condition and modify the required functions with a control message to avoid setting unrequired functions.

20 WAIT DELAY 1

It takes about 1 second for the MS420[ ] to reach power-on status.

30 WRITE @101: "ME0CT0IT"

About 15 minutes after power-up, the INTERNAL CAL. function executes for about 7 seconds. During this time, control messages are ignored. Therefore, set the INTERNAL CAL. TIMER to 0 minute (CT0) and execute it during the beginning of the program. After this, INTERNAL CAL. is not executed until IT is executed. Stop measurement (ME0) since INTERNAL CAL. is executed when measurement (sweep) stops or is terminated.

100 WRITE @101: "MS1"

Start in single sweep clarifies the relationship between measurement and data in the measurement memory.

110 WAIT DELAY 0.05

After start-up, the MS420[ ] waits 50 ms before reading the measurement termination status. If the MS420[ ] reads the measurement termination status in less than 50 ms after the start-up, it may read the old status.

8.3 Program for Measuring a 21.4 MHz Intermediate Frequency Filter

This program obtains the minimum loss, 3 dB bandwidth, and center frequency of a 21.4 MHz intermediate frequency filter by magnitude measurement.

```
Example Program :
The Amplitude Measurement of Filter

Measurement Conditions:
    1 TRACE --- MAGNITUDE
    2 CENTER --- 21.4MHz
    3 SPAN --- 30kHz
    4 RES BW --- 1kHz
    5 VIDEO BW --- 3kHz
    6 INPUT RANGE --- 0dB
    7 OUTPUT LEVEL --- 0dB
    8 SWEEP TIME --- 1.1sec
```

Fig. 8-1 Measurement Conditions

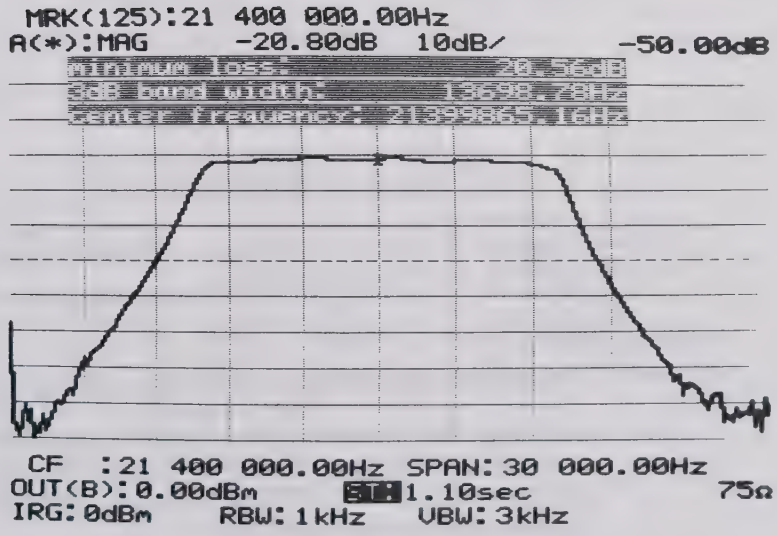
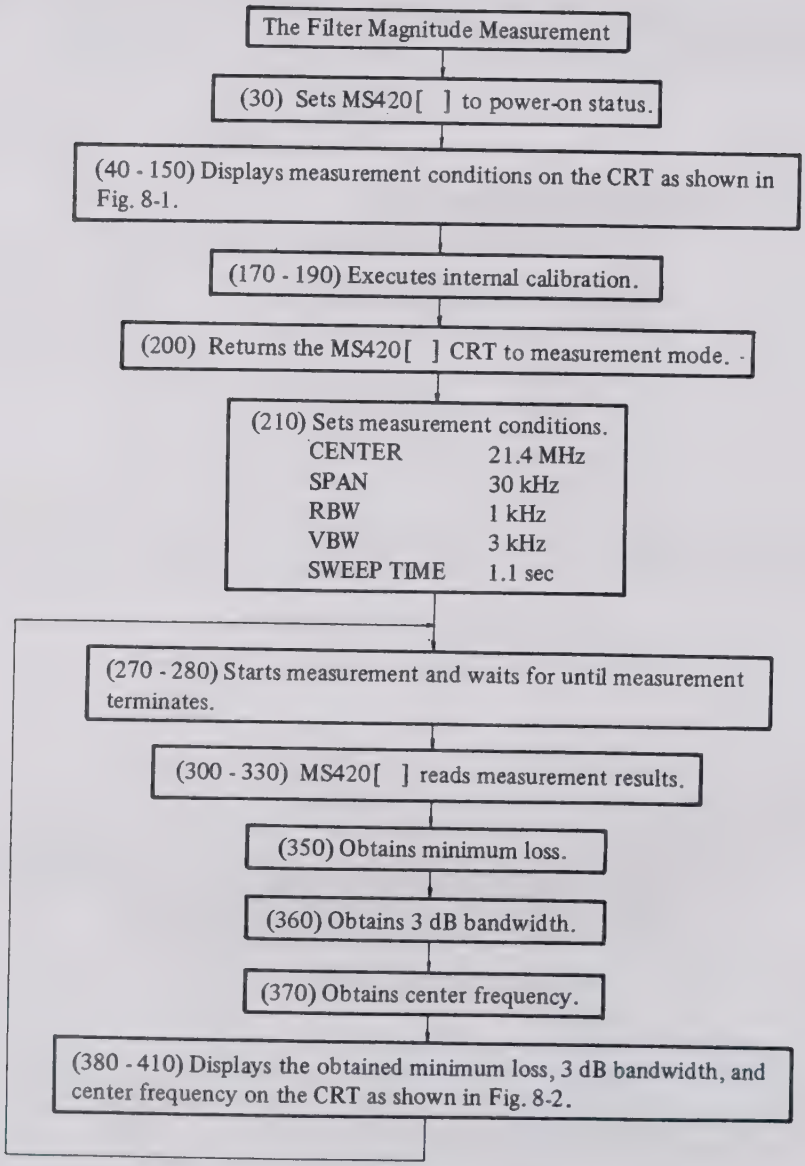


Fig. 8-2 CRT Display

(1) Flowchart


The Filter Magnitude Measurement
(30) Sets MS420[ ] to power-on status.
(40 - 150) Displays measurement conditions on the CRT as shown in Fig. 8-1.
(170 - 190) Executes internal calibration.
(200) Returns the MS420[ ] CRT to measurement mode.
(210) Sets measurement conditions.
CENTER 21.4 MHz
SPAN 30 kHz
RBW 1 kHz
VBW 3 kHz
SWEEP TIME 1.1 sec
(270 - 280) Starts measurement and waits for until measurement terminates.
(300 - 330) MS420[ ] reads measurement results.
(350) Obtains minimum loss.
(360) Obtains 3 dB bandwidth.
(370) Obtains center frequency.
(380 - 410) Displays the obtained minimum loss, 3 dB bandwidth, and center frequency on the CRT as shown in Fig. 8-2.

Note 1: The numbers in parentheses are program line numbers.

Note 2: INTERNAL CAL. is executed about 15 minutes after power on. Since control messages are ignored during INTERNAL CAL. execution, execute INTERNAL CAL. forcibly with IT by setting the timer to OFF with CT0.

(2) Program List

```
 10 REM "Filter Measurement"
 20 DIM FREQ(251),MAG(251)
 30 WRITE @101:"IN"
 40 WRITE @101:"CR0"
 50 WRITE @101:"CC1,0,185,Example Program :,"
 60 WRITE @101:"CC0,5,170,The Amplitude Measurement of Filter,"
 70 WRITE @101:"CC3,0,145,Measurement Conditions:,"
 80 WRITE @101:"CC2,20,130,1 TRACE --- MAGNITUDE,"
 90 WRITE @101:"CC2,20,120,2 CENTER --- 21.4MHz,"
100 WRITE @101:"CC2,20,110,3 SPAN --- 30kHz,"
110 WRITE @101:"CC2,20,100,4 RES BW --- 1kHz,"
120 WRITE @101:"CC2,20,90,5 VIDEO BW --- 3kHz,"
130 WRITE @101:"CC2,20,80,6 INPUT RANGE --- 0dBm,"
140 WRITE @101:"CC2,20,70,7 OUTPUT LEVEL --- 0dBm,"
150 WRITE @101:"CC2,20,60,8 SWEEP TIME --- 1.1sec,"
160 REM "start internal Calibration"
170 WRITE @101:"CT0IT"¥WAIT DELAY 10
180 WRITE @101:"ITR"
190 READ @101:CAL¥IF CAL=1 THEN 180
200 WRITE @101:"CR0"¥WRITE @101:"CR9"
210 WRITE @101:"FC21400000,30000BW6,7ST1100"
220 LET FREQ(0)=21385000¥LET FSTEP=120
230 FOR I=1 TO 250
240 LET FREQ(I)=FREQ(I-1)+FSTEP
250 NEXT I
260 REM "measure"
270 WRITE @101:"MS1"¥WAIT DELAY .1
280 WRITE @101:"MER"¥READ @101:ME¥IF ME=1 THEN 280
290 REM "read measurement data"
300 WRITE @101:"MMR0,251"
310 FOR I=0 TO 250
320 READ @101:MAG(I)
330 NEXT I
340 REM "data Processing"
350 GO SUB 1000
360 GO SUB 1200
370 GO SUB 1400
380 REM "display Processing data"
390 WRITE @101 USING "C,F7.2,C":"CC3,20,188,minimum loss:          ",MIN,"dB,"
400 WRITE @101 USING "C,F11.2,C":"CC3,20,178,3dB band width:    ",BAND,"Hz,"
410 WRITE @101 USING "C,F11.2,C":"CC3,20,168,center frequency: ",CENT,"Hz,"
420 INPUT PROMPT "next measurement ?":A$
430 GO TO 260
```

```
1000 REM "minimum loss"
1010 LET MIN=-200
1020 FOR I=0 TO 250
1030 IF MAG(I)<MIN THEN 1050
1040 LET PMIN=I¥LET MIN=MAG(I)
1050 NEXT I
1060 LET MIN=MIN*(-1)
1070 RETURN
1200 REM "3dB band width"
1210 LET LSTD=MIN*(-1)-3
1220 FOR I=PMIN TO 0 STEP -1
1230 IF MAG(I)<LSTD THEN 1250
1240 NEXT I
1250 LET P0=I
1260 FOR I=PMIN TO 250
1270 IF MAG(I)<LSTD THEN 1290
1280 NEXT I
1290 LET P1=I-1
1300 LET FQL=FREQ(P0)+(FREQ(P0+1)-FREQ(P0))*(MAG(P0)-LSTD)/(MAG(P0)-MAG(P0+1))
1310 LET FQH=FREQ(P1)+(FREQ(P1+1)-FREQ(P1))*(MAG(P1)-LSTD)/(MAG(P1)-MAG(P1+1))
1320 LET BAND=FQH-FQL
1330 RETURN
1400 REM "center frequecy"
1410 LET CENT=FQL+BAND/2
1420 RETURN
1430 END
```

8.4 Program for Rapid Measurement by Decreasing Measurement Points

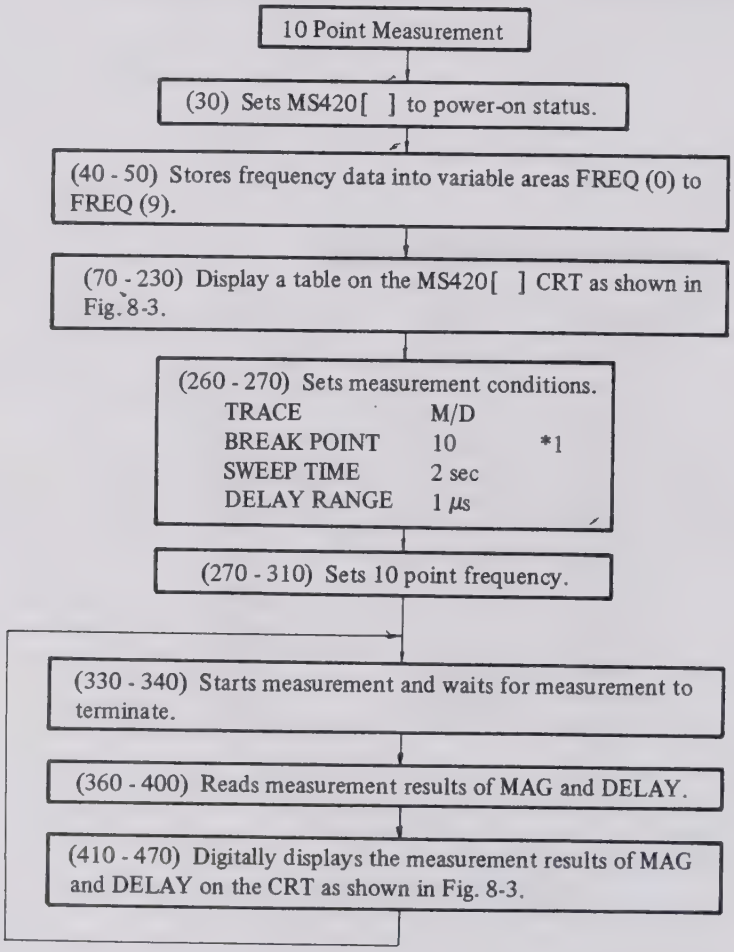
This program measures 10 points of magnitude and delay, and displays them on the screen as shown in Figure 8-3.

10 POINTS MEASUREMENT

FREQENCY (MHz)	MAG (dB)	DELAY(range:1us) (ns)
1.0	-91.32	160
1.1	-92.12	72
1.2	-89.81	161
1.3	-88.98	-267
1.4	-90.54	132
1.5	-89.83	14
1.6	-91.77	-249
1.7	-92.09	548
1.8	-87.67	159
1.9	-90.00	368

Fig. 8-3 Digital display of 10 point measurement

(1) Flowchart


10 Point Measurement
(30) Sets MS420[ ] to power-on status.
(40 - 50) Stores frequency data into variable areas FREQ (0) to FREQ (9).
(70 - 230) Display a table on the MS420[ ] CRT as shown in Fig. 8-3.
(260 - 270) Sets measurement conditions.
TRACE M/D
BREAK POINT 10 *1
SWEEP TIME 2 sec
DELAY RANGE 1 μs
(270 - 310) Sets 10 point frequency.
(330 - 340) Starts measurement and waits for measurement to terminate.
(360 - 400) Reads measurement results of MAG and DELAY.
(410 - 470) Digitally displays the measurement results of MAG and DELAY on the CRT as shown in Fig. 8-3.

Note 1: *The number in parentheses indicates the program number.*

Note 2: **1 BREAK POINT indicates the measurement point of sweep termination.*

o Control message

BRI *l: 1 ~ 251*
(If l is set to 252 to 255, the current sweep status is returned to the normal sweep mode.)

o Data request message

BPR

(2) Program List

```
 10 REM "the amplitude & delay measurement of 10 Point"
 20 DIM FREQ(9),MAG(9),DLY(9)
 30 WRITE @101:"IN"
 40 MAT READ FREQ
 50 DATA 1,1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9
 60 REM "control MS420A/J CRT"
 70 WRITE @101:"CR0"
 80 WRITE @101:"CC1,0,208,10 POINTS MEASUREMENT,"
 90 WRITE @101:"CC0,0,180, FREQENCY    MAG    DELAY(range:1us),"
100 WRITE @101:"CC0,0,168,  (MHz)      (dB)    (ns),"
110 LET Y=155
120 FOR I=0 TO 9
130 WRITE @101 USING "C,A,C,F4.1,C":"CC0,10,",Y,",",FREQ(I),","
140 LET Y=Y-15
150 NEXT I
160 WRITE @101:"CG1,2,193,220,193"
170 FOR Y=166 TO 10 STEP -15
180 WRITE @101 USING "C,A":"CG1,2,",Y,",220,",Y
190 NEXT Y
200 WRITE @101:"CG1,2,16,2,193"
210 WRITE @101:"CG1,60,16,60,193"
220 WRITE @101:"CG1,110,16,110,193"
230 WRITE @101:"CG1,220,16,220,193"
240 REM "set measurement conditions"
250 WRITE @101:"ME1CT0IT"¥WAIT DELAY 10
260 WRITE @101:"TR7BP10ST2000"
270 WRITE @101:"DR0F00"
280 REM "store in frequency memory"
290 FOR I=0 TO 9
300 WRITE @101 USING "A":FREQ(I)*1000000
310 NEXT I
320 REM "measure start/end"
330 WRITE @101:"MS1"¥WAIT DELAY .05
340 WRITE @101:"MER"¥READ @101:ME¥IF ME=1 THEN 340
350 REM "read amplitude & delay"
360 WRITE @101:"MMR0,10"
370 FOR I=0 TO 9
380 READ @101:MAG(I)
390 READ @101:DLY(I)
400 NEXT I
410 LET Y=155
420 REM "Print amplitude & delay"
430 FOR I=0 TO 9
440 WRITE @101 USING "C,A,C,F7.2,C":"CC0,60,",Y,",",MAG(I),","
450 WRITE @101 USING "C,A,C,F5.0,C":"CC0,130,",Y,",",DLY(I),","
460 LET Y=Y-15
470 NEXT I
480 GO TO 330
490 END
```

8.5 Program for Measuring Input Signal Frequency and Level

This program measures the frequency and level of approx. 10 MHz input signal.

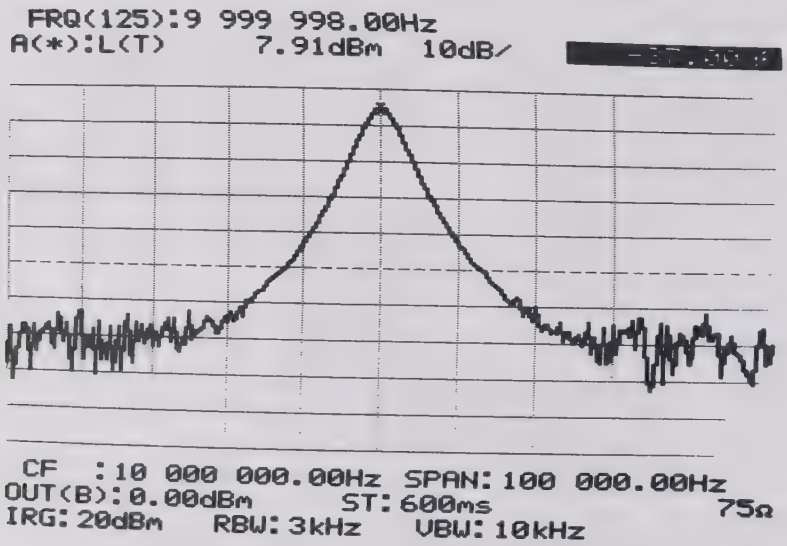
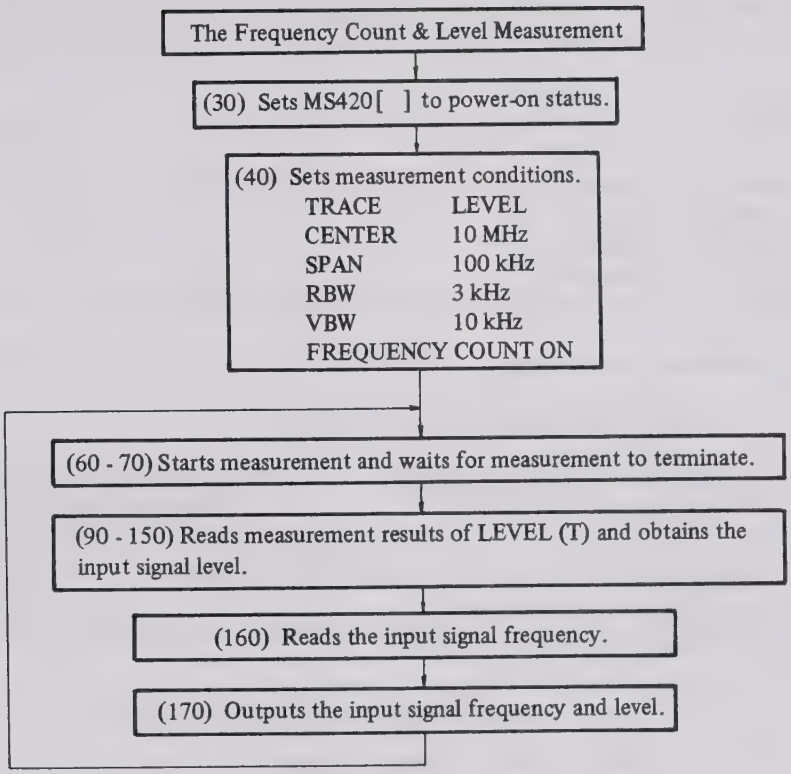

FRQ(125):9 999 998.00Hz
A(*):L(T) 7.91dBm 10dB/
CF :10 000 000.00Hz SPAN: 100 000.00Hz
OUT(B): 0.00dBm ST: 600ms 75Ω
IRG: 20dBm RBW: 3kHz VBW: 10kHz

Fig. 8-4 MS420[ ] CRT during frequency measurement

Note: Since the frequency is measured after the sweep is terminated, read the measurement value of the frequency (MFR) about 1.5 seconds after sweep termination.

(1) Flowchart


The Frequency Count & Level Measurement
(30) Sets MS420[ ] to power-on status.
(40) Sets measurement conditions.
TRACE LEVEL
CENTER 10 MHz
SPAN 100 kHz
RBW 3 kHz
VBW 10 kHz
FREQUENCY COUNT ON
(60 - 70) Starts measurement and waits for measurement to terminate.
(90 - 150) Reads measurement results of LEVEL (T) and obtains the input signal level.
(160) Reads the input signal frequency.
(170) Outputs the input signal frequency and level.

Note: The value in parentheses indicates the program number.

(2) Program list

(A)

```
10 REM "the frequency count & level measurement"
20 REM "set measurement conditions"
30 WRITE @101:"IN"
40 WRITE @101:"TR4FC10000000,100000BW7,8FD1"
50 REM"measure start/end"
60 WRITE @101:"MS1"¥WAIT DELAY .5
70 WRITE @101:"MER"¥READ @101:ME¥IF ME=1 THEN 70
80 REM"read frequency & level"
90 WRITE @101:"MMR0,251"
100 LET LEVEL=-200
110 FOR I=0 TO 250
120 READ @101:LVLT
130 IF LVLT<LEVEL THEN 150
140 LET LEVEL=LVLT
150 NEXT I
160 WRITE @101:"MFR"¥READ @101:FREQ
170 PRINT FREQ;"Hz";LEVEL;"dBm"
180 GO TO 50
190 END
```

8.6 FREQUENCY OFFSET TRACKING

Connecting the MS420[ ] to any of the following synthesizers through the GP-IB allows tracking by frequency shifting. This function is used to test devices such as mixers that have difference input and output frequencies.

Synthesizers:

- MS443B (Anritsu)
- MG545[ ] (Anritsu)
- MG440[ ] (Anritsu)
- 178 (Wavetek)
- 3336 (Hewlett Packard)

(1) Synthesizer Control Format:

These formats are set using the ADV FUNCTION.

11 WRITE [#] ○ , ○ [EOL]

Format

Synthesizer's GP-IB address

(a) Format "A" . . . . . for MG440A/K, MG545A/K, or MG443B in only mode.

F ○○○○○○○○○○ (CR)(LF)

GHz MHz kHz Hz

(b) Format "B" . . . . . for MG440C/M or MG545C/M

○○○○○ . ○○ ; ␣

Point (.)

(c) Format "C" . . . . . for Wavetek 178

F ○○○○ , ○ I (CR)(LF)

(d) Format "D" . . . . . for MG443B

FQ ○○○○○○○○ (CR)(LF)

(e) Format "E" . . . . . for HP3336

FF ○○○○○ . ○○ HZ (CR)(LF)

(f) Format "F" . . . . . for MG443B in high speed mode

Special format

Note: Format "F" cannot be used at logarithmic frequency sweep.

(2) Connection

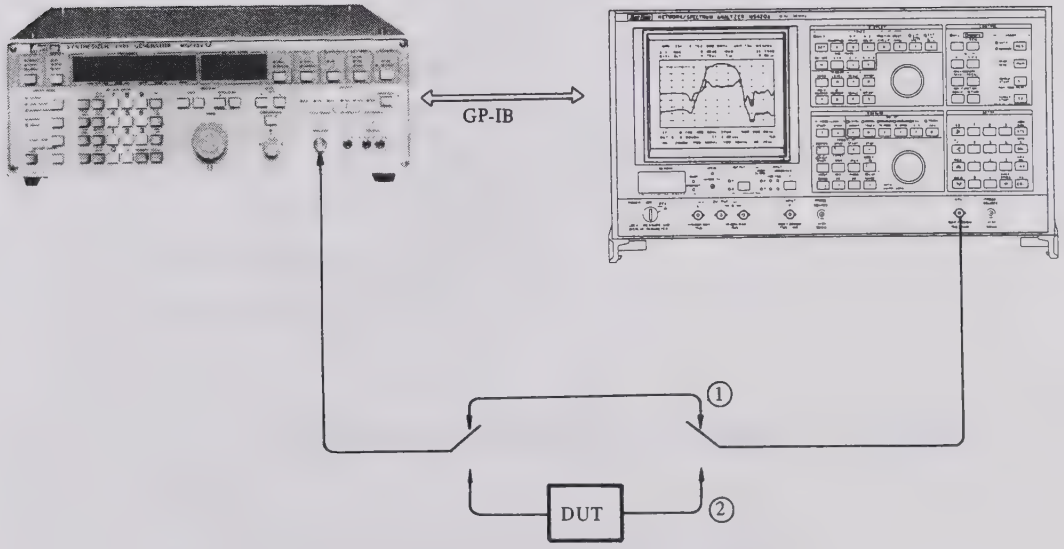
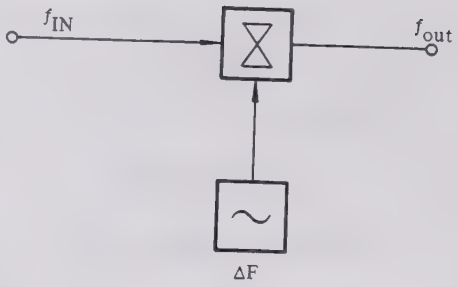


Fig. 8-5 Connections

(3) Frequency Conversion System

Any one of the three modes shown in Fig. 8-6 can be selected with the frequency conversion system.



MODE	Conversion system
0	f_{out} : $f_{IN} + \Delta F$ • $f_{out} \leqq 30$ MHz
1	f_{out} : $f_{IN} - \Delta F$ • $f_{IN} > \Delta F$ • $f_{out} \leqq 30$ MHz • f_{IN}: 10 Hz to 500 MHz
2	f_{out} : $\Delta F - f_{IN}$ • $\Delta F > f_{IN}$ • $f_{out} \leqq 30$ MHz • f_{IN}: 10 Hz to 500 MHz

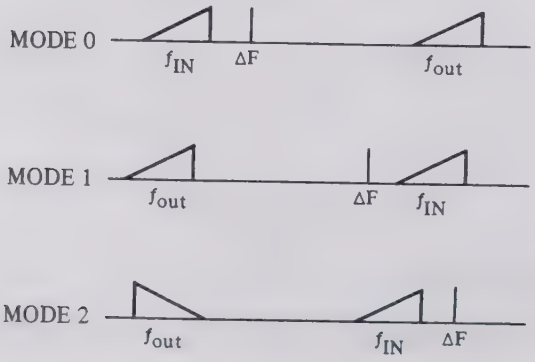


Fig. 8-6 Frequency Conversion System

(4) GP-IB MESSAGE

The following control messages and data request messages have been added.

(a) Frequency sweep mode

- Control message

FPn

n = 0 : LOG START/STOP
1 : START/STOP
2 : CF/SPAN

- Data request message

FPR

(b) SAVE FUNCTION

- Control message

SV1, 7

Trace conditions on the CRT are saved to the PBM.

(c) RECALL FUNCTION

- Control message

RC1, 7

Trace conditions saved in the PBM are displayed on the CRT in low-intensity mode.

RC1, 8

The low-intensity screen is erased and replaced by a scale line.

RC0, 3

The offset is automatically set to the marker readout value.

RC0, 4

SPAN is automatically set to the frequencies pointed by the two markers.

RC0, 5

The center frequency is automatically set to the main marker frequency.

RC0, 6

The main marker is automatically set to the top of trace-A.

RC0, 9

The MS420[ ]is initialized when the power is turned on.

(4) Offset tracking

- Mode and ΔF

FTm, ℓ

m = 0 to 2 : mode
ℓ = 0 to 1000 000 000 .00 : ΔF

- Format

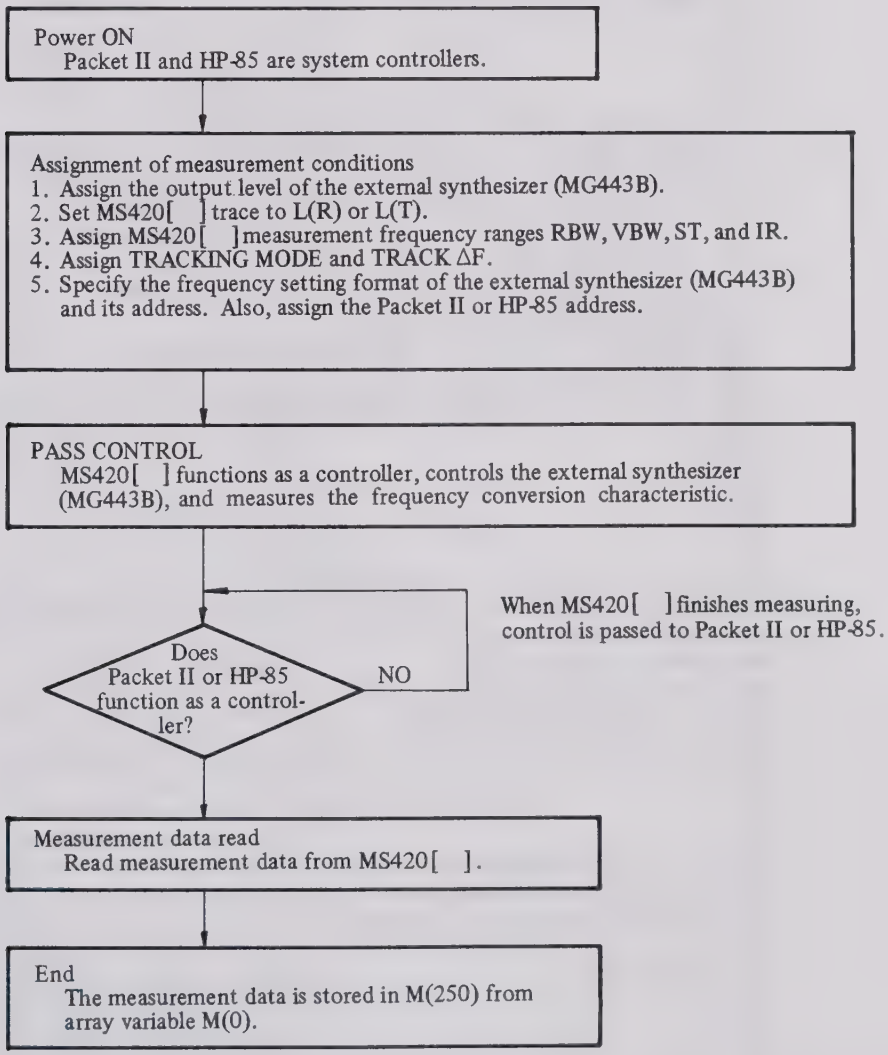
WTm0, m1, m2

m0 = A to F : Synthesizer's model
(See paragraph 8.6.(1))
m1 = Synthesizer's address
m2 = Controller's address

(5) FREQUENCY CONVERSION CHARACTERISTIC MEASUREMENT PROGRAM

Packet II and HP-85 program examples are described.

(a) Flowchart


Power ON
Packet II and HP-85 are system controllers.
Assignment of measurement conditions
1. Assign the output level of the external synthesizer (MG443B).
2. Set MS420[ ] trace to L(R) or L(T).
3. Assign MS420[ ] measurement frequency ranges RBW, VBW, ST, and IR.
4. Assign TRACKING MODE and TRACK ΔF.
5. Specify the frequency setting format of the external synthesizer (MG443B) and its address. Also, assign the Packet II or HP-85 address.
PASS CONTROL
MS420[ ] functions as a controller, controls the external synthesizer (MG443B), and measures the frequency conversion characteristic.
When MS420[ ] finishes measuring, control is passed to Packet II or HP-85.
Does Packet II or HP-85 function as a controller?
NO
Measurement data read
Read measurement data from MS420[ ].
End
The measurement data is stored in M(250) from array variable M(0).

(b) Packet II Program Example

```
 10 REM "measurement of frequency offset tracking"
 20 REM "MS420[] uses Pass control function"
 30 DIM M(250)
 40 COM CFLAG
 50 LET MS420=101¥LET MG443=102
 60 WRITE @MS420:"IN"¥WAIT DELAY 1
 70 !
 80 !
 90 !
100 REM "set measurement conditions"
110 WRITE @MG443:"LV-20.00"!MG443A output level =-20.00dBm
120 WRITE @MG420:"TR4"!TRACE is L(T)
130 WRITE @MG420:"FS10000,20000BW6,7ST4000IR2"
140 !start frequency is 10kHz,stop frequency is 20kHz
150 !resolution BW is 1kHz,video BW is 3kHz
160 !sweep time is 4sec,input range is -20dBm
170 WRITE @MS420:"FT0,12000"
180 !TRACKING MODE is 0,TRACK ^F is 12kHz
190 WRITE @MS420:"WTD,2,20"
200 !tracking format is D,MG443A address is 2,Packet address is 20
210 !
220 !
230 !
240 !
250 !
260 REM "Process GP-IB interrupt"
270 PROCESS EVENT GPIB"@01,00"!interrupt by becoming controller
280 START PASSCONTROL
290 CONNECT EVENT GPIB
300 REM "PASS CONTROL"
310 LET CFLAG=1¥PCT @MS420
320 IF CFLAG=1 THEN 320! ? Packet becomes controller
330 !
340 !
350 !
360 REM "read measurement data"
370 WRITE @MS420:"MMR0,251"
380 MAT READ @MS420 USING "F9":M
390 !
400 GO TO 300
410 !
420 !
430 END
440 !
450 !
460 !
1000 PARACT PASSCONTROL URGENCY 70
1010 COM CFLAG
1020 WAIT EVENT GPIB
1030 LET CFLAG=0
1040 GO TO 1020
1050 END PARACT
1060 !
1070 !
1080 !
```

(c) HP-85 Program Example

The data read time from MS420[ ] is reduced using an I/O buffer memory.

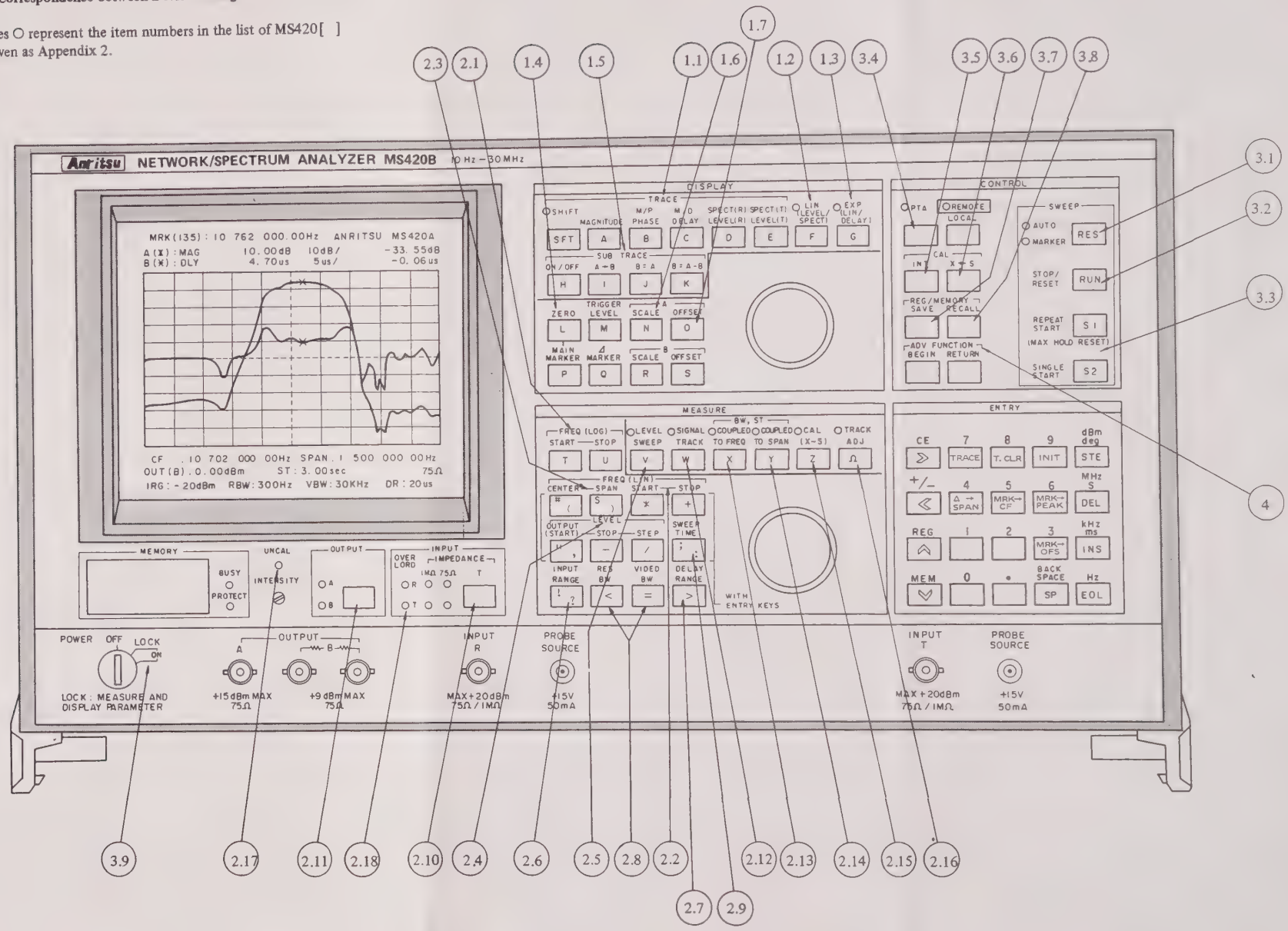
Read time when the I/O buffer memory is used: Approximately 0.5 sec.

Read time when not used: Approximately 15 sec.

```
10 REM "measurement of frequenc
   yoffset tracking"
20 REM "MS420[] uses pass contr
   ol function"
30 DIM M(250),Z$[2267]
40 IOBUFFER Z$
50 OUTPUT 701 ;"IN" ! set initi
   alized MS420[]
60 WAIT 1000
70 !
80 !
90 !
100 REM "set measurement conditi
    ons"
110 OUTPUT 702 ;"LV-20.00" ! MG4
    43A output level =-20.00dBm
120 OUTPUT 701 ;"TR4" ! TRACE is
     L(T)
130 OUTPUT 701 ;"FS10000,20000BW
    6,7ST4000IR2"
140 ! start frequency is 10kHz,s
    top frequency is 20kHz
150 ! resolution BW is 1kHz,vide
    o BW is 3kHz
160 ! sweep time is 4sec,input r
    ange is -20dBm
170 OUTPUT 701 ;"FT0,12000"
180 ! TRACKING MODE is 0,TRACK ^
    F is 12kHz
190 OUTPUT 701 ;"WTD,2,21"
200 ! tracking format is D,MG443
    A address is 2,HP-85 address
     is 21
210 !
220 !
230 !
240 !
250 !
260 REM "pass control"
270 PASS CONTROL 701
280 WAIT 100
290 STATUS 7,5 ; S
300 IF BIT(S,5)<>1 THEN 290
310 !
320 !
330 !
340 !
350 REM "read mesurement datas"
360 OUTPUT 701 ;"MMR0,251"
370 TRANSFER 701 TO Z$ FHS ; COU
    NT 2267
380 FOR I=0 TO 250
390 ENTER Z$ ; M(I)
400 NEXT I
410 END
```

APPENDIX 1 Correspondence between Device Messages and Function Keys

The values in circles ○ represent the item numbers in the list of MS420[ ] device messages given as Appendix 2.

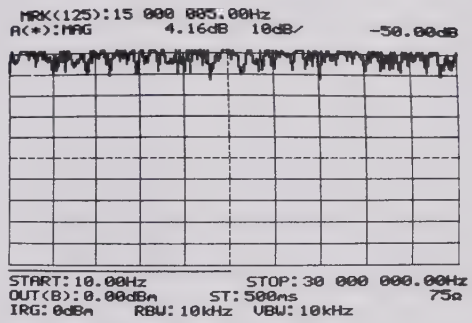


APPENDIX 2 LIST OF MS420[ ] DEVICE MESSAGES

Item number	Function		Control message	Data request message
1.1	Display functions	TRACE	TRm	TRR
1.2		LIN/IF ATT/TRIGGER LEVEL	LIn, m, ℓ	LIR
1.3		EXP	EXn	EXR
1.4		MARKER	MKm, ℓ	MKR
1.5		SUB TRACE	AXn, m	AXR
1.6		SCALE A/B	SCm1, m2	SCR
1.7		OFFSET A/B	OFℓ1, ℓ2	OFR
2.1	Measurement functions	LOG START/STOP FREQUENCY	FLm1, m2	FLR
2.2		START/STOP FREQUENCY	FSℓ1, ℓ2	FSR
2.3		CENTER/SPAN FREQUENCY	FCℓ1, ℓ2	FCR
2.4		START (OUTPUT)/STOP/STEP LEVEL	LLℓ1, ℓ2, ℓ3	LLR
2.5		LEVEL SWEEP	LWn	LWR
2.6		INPUT RANGE	IRm	IRR
2.7		DELAY RANGE	DRm	DRR
2.8		RES/VIDEO BW	BWm1, m2	BWR
2.9		SWEEP TIME	STℓ	STR
2.10		IMPEDANCE (R)/(T)	IMm1, m2	IMR
2.11		OUTPUT A/B	OPm	OPR
2.12		SIGNAL (AUTO) TRACK	ATn	ATR
2.13		COUPLED TO FREQ	CFn, m	CFR
2.14		COUPLED TO SPAN	CPn	CPR
2.15		CAL X–S	XSn	XSR
2.16		TRACK ADJ	BTn, ℓ	BTR
2.17		UNCAL		UCR
2.18		OVER LOAD		OVR
3.1	Control functions	SWEEP AUTO/MARKER	AMn	AMR
3.2		SWEEP STOP/RESET	MEm	MER
3.3		SWEEP REPEAT/SINGLE START	MSm	
3.4		PTA (OPTION 01)	PTn	PTR
3.5		INTERNAL CAL	IT	
3.6		X→S CAL	CS	
3.7		SAVE	SVm1, m2	
3.8		RECALL	RCm1, m21	
3.9		INITIAL SET	IN	
4.1	Advance functions	INTEGRATING	IGn	IGR
4.2		MAX. HOLD	MHn	MHR
4.3		FREQUENCY COUNT	FOn	FOR
4.4		SWEEP MARKER	SMn	SMR
4.5		BUZZER	BZn	BZR
4.6		AUTO CAL. TIMER	CTℓ	CTR
4.7		TITLE	TT, abc,	TTR
4.8		SRQ	SQn	SQR
4.9		DELIMIT	DMn	DMR
4.10		SEND		SDR
5.1	Measurement data	FREQUENCY MEMORY	FQℓ	FRQℓ1, ℓ2
5.2		LEVEL MEMORY	LVℓ	LVRℓ1, ℓ2
5.3		Measurement memory for channel A	XAℓ	XARℓ1, ℓ2
5.4		Measurement memory for channel B	XBℓ	XBRℓ1, ℓ2
5.5		S memory for channel A	SAℓ	SARℓ1, ℓ2
5.6		S memory for channel B	SBℓ	SBRℓ1, ℓ2
5.7		Reading measurement results		MMRℓ1, ℓ2
6.1	CRT	Display deletion	CRm	
6.2		Character display	CCm, X, Y	
6.3		Graphic display	CGm, X1, Y1, X2, Y2	

APPENDIX 3 FRONT PANEL STATUS AT POWER-ON

(1) CRT display



(2) Function

LIN --- OFF
EXP --- OFF

TRACE	SCALE	OFFSET
PHASE	50 deg/	0 deg
DELAY	100 ms/	0 ms
L(R), S(R)	10 dB/	−50 dBm
L(T), S(T)	10 dB/	−50 dBm

FREQ (LOG)
START --- 10 Hz
STOP --- 30 MHz

FREQ (LIN)
CENTER --- 15000000.00 Hz
SPAN --- 30000000.00 Hz
LEVEL
OUT (START) --- 0 dBm
STOP --- 9 dBm
DELAY RANGE --- 400 mS
LEVEL SWEEP --- OFF
SIGNAL TRACK --- OFF
COUPLED TO FREQ --- OFF
COUPLED TO SPAN --- OFF
CAL (X-S) --- OFF
TRACK ADJ --- OFF
SWEEP
AUTO/MARKER --- AUTO
REPEAT --- ON
ADV FUNCTION
INTEGRATING --- OFF
MAX HOLD --- OFF
IMPEDANCE(R) --- 75 Ω
FREQ COUNT --- OFF
TRACKING ΔF --- 0 Hz
TRACKING MODE --- 0
AUTO CAL TIME --- 0
SWEEP MARKER --- ON
BUZZER --- ON

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